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MARSHALL ON ECONOMIC GROWTH

ALL of Marshall's books and many of his occasional writings contain something of his views on economic development as a historical process. None of them contains a complete or particularly elaborate statement, the fuller developments being found in *Industry and Trade* and in the first edition of the *Principles*. To attempt an exposition of Marshall's views on this subject therefore requires the collation of a good deal of material, published over thirty-six years, and written, in all probability, over a still greater period of time. This does not seem to matter much, however, as the views expressed in *Money, Credit, and Commerce,* published in 1923, do not differ markedly from those to be found in the *Principles* or in the evidence given before the Gold and Silver Commission in 1887.

I

Marshall never produced a theory of economic growth, and there is no such thing as a 'Marshallian system'. To speak of Marshall's 'determinants' of economic growth is therefore apt to be misleading unless the word is dissociated from the idea of some logically complete construct. What Marshall did was to outline the nature and operation of certain forces which he considered to be of prime importance in causing or facilitating economic development. For the sake of brevity we may call these forces determinants of economic growth ; and taking the word in this slightly special sense, we may conveniently separate the Marshallian determinants into three classes. First, there are the long-run, fundamental determinants ; secondly, there are those influences which seem to bulk large enough in Marshall's treatment to be called major, but which differ from the fundamental determinants in being of a more economic, man-made character ; and thirdly, there are the minor influences. This classification is of course somewhat arbitrary, but it is a helpful one in summarising Marshall's ideas.

Fundamental Determinants

Marshall lists four determinants which are long-run and fundamental in their working, although the fourth is of a somewhat different nature from the other three. Basic and unalterable, there are climate, and natural resources and advantages conveniently disposed. Where nature is ungenerous, there is no surplus out of which progress may begin to be derived. 'And therefore, as Buckle has pointed out, all early civilisations have been in warm climates where the necessaries of life are small, and where Nature makes bountiful returns even to the rudest cultivation.'[1] But progress here cannot be sustained ; physical toil is too hard, intellectual dilettantism too easy, and therefore it is in the ' invigorating atmosphere ' of ' colder climates ',[2] where, moreover, the sea provides man with the possibility of constant intercourse, ' knowledge, freedom and the power of variation ', that progress finally takes root and continues. And after these two, there is human character. Thus we learn that the ' strength of character of the Romans fitted them for business ';[3] that the United States owes some of its prosperity to its being inhabited by ' a mixture of races of great energy and alertness ';[4] that the English ' from 1066 down to the present time . . . the same people '[5] after centuries of economic backwardness ' at last . . . threw their own special characteristics into business affairs with such energy, and such quickness of adaptation to the ever-increasing massiveness of the economic problems of the Western World, that they became its chief pioneers of progress and trade '.[6]

The fourth fundamental determinant is not a ' natural ' but a political one : this is human freedom. Economic growth is depicted by Marshall, in fact, almost as the material counterpart of the growth of freedom, the second of the two great co-variants of history. Thus we are reminded that primitive societies suffer from the rule of custom, probably ' the most important of all the causes which have delayed the growth of the spirit of free enterprise among mankind ';[7] the cities of the Middle Ages, we are told, ' led the way towards modern industrial civilization ' and might have realised it had they retained ' their first love of liberty and social equality ';[8] only an inferior

[1] Alfred Marshall, *Principles of Economics* (London, 1890), Book I, Ch. 2, sect. 1. All references to the *Principles* are to the first edition unless otherwise stated. Passages corresponding to those quoted are as a rule to be found in Appendix A of the later editions.

[2] *Principles*, Book I, Ch. 2, sect. 1. See also *Principles*, Book I, Ch. 3, sects. 1 and 3.

[3] *Ibid.*, Book I, Ch. 2, sect. 4.

[4] *Money, Credit, and Commerce* (London, 1923), p. 221.

[5] *Industry and Trade* (London, 1919), p. 35.

[6] *Ibid.*, p. 35.

[7] *Principles*, Book I, Ch. 2, sect. 2.

[8] *Ibid.*, Book I, Ch. 2, sect. 7.

development can be achieved by those who, whatever their 'industrial virtues', are 'more patient and more easily contented, more submissive and less full of initiative', more tolerant of 'bureaucratic management',[9] than the English and the Americans.

Next after this group, more precise and for the most part more specifically economic, come what we have called the major influences in Marshall's conception of economic growth. There are five of these, two of them evidently of greater importance than the others.

Major Influences

First there stands a composite sort of influence which could be described as the willingness and ability to save. This is dealt with most fully in the *Principles*, away from the more general discussions of economic growth, but it is nowhere forgotten. The fundamental point here is simple: 'with the growth of openings for the investment of capital there is a constant increase in that surplus of production over the necessaries of life, which gives the power to save.'[10] And with the growth of this power there may well go a growth of inclination, a strengthening of 'habits of forethought and the willingness to incur present exertion in the expectation of a remote benefit'.[11]

This idea is elaborated in three different directions. First, there must be security for savings: 'The thriftlessness of early times was in a great measure due to the want of security that those who made provision for the future would enjoy it.'[12] Secondly, there is the part played by the institution of money: 'The growth of a money-economy and of modern habits of business does indeed hinder the accumulation of wealth by putting new temptations in the way of those who are inclined to live extravagantly. . . . But . . . a money-economy increases the variety of the uses between which a person can distribute his future expenditure. . . . And, what has had a far greater effect on the growth of wealth, it has rendered it far easier for a man to provide a secure income for his wife and children after his death; for, after all, family affection is the main motive for saving.'[13]

Lastly, there is the question of the distribution of income; and here Marshall seems to have been of two minds. In the chapter of the *Principles* from which we have been quoting, the matter is put in this way: 'The power to save depends on an excess of income over necessary expenditure; and this is greatest among the wealthy. But . . . the older economists took too little account of the fact that

[9] *Memorials of Alfred Marshall*, edited by A. C. Pigou (London, 1925), p. 275.
[10] *Principles* (8th ed.), Book IV, Ch. 7, sect. 2.
[11] *Industry and Trade*, p. 143.
[12] *Principles* (8th ed.), Book IV, Ch. 7, sect. 4.
[13] *Ibid.*, Book IV, Ch. 7, sect. 5.

human faculties are as important a means of production as any other kind of capital ; and we may conclude, in opposition to them, that any change in the distribution of wealth which gives more to the wage receivers and less to the capitalists is likely, other things being equal, to hasten the increase of material production, and that it will not perceptibly retard the storing up of material wealth.'[14] To this Marshall adds that such redistribution may even, given time, contribute to the growth of accumulated physical capital. This view is repeated in *The Economics of Industry* (1892).[15] But in *Industry and Trade* (1919) the argument seems to be, on the whole, that the existence of large gains by large capitalists in risky undertakings, leading to ' an exceptionally large aggregate of new income in the hands of the commercial classes ',[16] is, at least in the case of the United States in the second half of the nineteenth century, of benefit to economic growth. And there seems to be an implication that this view could be generalised.

The second major influence of seemingly outstanding importance in Marshall's thought is also a composite one, usually to be found under the heading of improved transport or ' massive production '. In Marshall's thought improved transport, external economies and the law of increasing return are intimately and inseparably bound up with one another ; and in the well-known passage in Book V of the *Principles*,[17] in which Marshall hovers on the verge of a discussion of imperfect competition, it is the cost of transport which is called in to preserve the existence of the small manufacturer working in a sphere of production subject to the law of increasing return ; and that preservation is not of a very sure kind, for ' time is on the side of the more economic methods of production ', *i.e.* the costs of distribution are apt to diminish with time. This type of argument appears again and again when Marshall is discussing economic expansion. In *Industry and Trade*[18] the ' slowness of the growth of foreign trade ' between 1660 and 1760 is ascribed to the fact that ' the new markets beyond the seas were really very narrow ', due to the uncertainty and high cost incurred in the carriage of merchandise. This is the prelude to a brief account of transport improvements in England in the eighteenth century, and the section ends : ' Each victory [over difficulties] tended to increase the area over which the goods could be marketed, and therefore the scale of production ; and therefore

[14] *Ibid.*, Book IV, Ch. 7, sect. 7.
[15] *Op. cit.*, p. 135.
[16] *Op. cit.*, pp. 154-55.
[17] *Principles* (8th ed.), Book V, Ch. 7, sect. 2.
[18] *Op. cit.*, p. 37.

in many industries at least the economy of production ; and therefore again the area over which the goods could be marketed ; and so on in ever widening circles.'[19] An identical argument helps to explain what Marshall held to have been the ' exceptionally great changes ' in industry in the decade or two prior to 1887 ; ' the changes are, I think, chiefly due to the great fall, the unparalleled fall, in the cost of transport, which renders it worth while to do a great many things that it was not worth while to do before '.[20]

The three remaining ' major influences ' may be dealt with more briefly. Chief among them perhaps, and closely connected with the second, is the conjuncture of Petty's ' great rule ' that ' each country flourisheth in the manufacture of its own native commodities ',[21] with the fact of one of these native commodities being ' so uniform in substance and in shape as to give large scope for play of the economies ' of specialisation.[22] This is exemplified by wool and iron in England, and shipbuilding in Holland in the seventeenth and eighteenth centuries. Next there is the importance of a country's having had experience of capitalistic forms of organisation before embarking upon large-scale production. Thus it is argued that entrepreneurs in England gained invaluable experience in organising the cottage industries long before the advent of the factories. Lastly, and mentioned only once in Marshall's writings although clearly of great consequence, there is the ' temporary suspension of the pressure of the Law of Diminishing Return from land '. ' The Law of Diminishing Return [to national effort?] is almost inoperative in Britain just now [1907], but after a generation or two it may again be a powerful influence here and nearly all over the world. Wages in Britain are now but very little affected by the rate of growth of population and the pressure on the means of subsistence. . . . But the world is really a very small place, and there is not room in it for the opening up of rich new resources during many decades at as rapid a rate as has prevailed during the last three or four. When new countries begin to need most of their own food and other raw produce, improvements in transport will count for little. From that time onward the pressure of the Law of Diminishing Return can be opposed only by further improvements in production ; and improvements in production must themselves gradually show a diminishing return.'[23]

[19] *Industry and Trade*, p. 41.
[20] Evidence before the Gold and Silver Commission, Q. 9831.
[21] *Industry and Trade*, p. 33.
[22] *Ibid.*, p. 55.
[23] *Memorials of Alfred Marshall*, p. 326.

Minor Influences

We now come to those influences which seem least important in Marshall's structure of ideas, and which we have classified as minor influences. Four of them are worth mentioning. First of all, alluded to in nearly every one of Marshall's works, there is the importance to a nation of having a ' middle class '. Thus we are told that in seventeenth-century England ' the middle class and some parts of the working class adopted a severe view of life ' and promoted industrial development by concentrating upon the production of articles ' with a solid and lasting utility ';[24] by contrast, in eighteenth-century France the ' luxury of the rich and the poverty of the poor combined to make France a bad market for substantial simple goods, which are not choice enough for the rich, nor cheap enough for the common people '.[25] A middle class, in short, provides a market for goods well adapted to ' massive production ', while the ' fusion of different ranks '[26] in society breeds that business enterprise which can take advantage of such a market. Secondly, the importance of efficient and reasonably incorruptible government is stressed. Education also receives a brief mention and, lastly, there is an almost equally brief reference to the rôle of prices. It seems beyond question that as far as economic growth was concerned Marshall attached little importance to changes in the price level—at any rate to changes such as had been known in the nineteenth century. In *Industry and Trade* there is a mild suggestion on page 87 that rising prices retard economic growth, and on page 88 an equally mild suggestion that they help it. In the evidence before the Gold and Silver Commission the argument is, on the whole, in favour of falling prices because manufacturers are then obliged ' to exert themselves to the utmost ' and lenders to be ' much more careful about their loans '.[27] But not much importance seems to be attached to the argument.[28]

To sum up, Marshall insists chiefly on the importance of climate, of the national character (which he admits is in part determined by natural and institutional factors), of the capacity to save, and of ' massive production '. The great secret of economic growth is to achieve this last, but it is a complex idea. If the first two are right—and much stress is laid on the second—then what chiefly matters is the possession of *home* resources, which may readily be utilised to increase

[24] *Principles*, Book I, Ch. 3, sect. 3.
[25] *Industry and Trade*, pp. 110-11.
[26] *Principles*, Book I, Ch. 3, sect. 1.
[27] Evidence before the Gold and Silver Commission, Q. 9816.
[28] A general statement of Marshall's position on this point is to be found in *Official Papers by Alfred Marshall*, pp. 7-10.

the capacity to save and to achieve massive production, and the existence of extensive markets. Help is also given if men and ideas are mobile and can readily be got together—this tells in favour of the United States and Great Britain and against France—if there are institutional arrangements which encourage the trading of present for future benefits, and if there is a middle class to demand 'solid wares' in quantity; it is also helpful if there is social mobility. Honest government, education, the distribution of income and the behaviour of prices—all of these are worth a mention but scarcely more. Everywhere the importance of improved transport is insisted upon.

II

No brief summary does justice to an ably-developed historical exposition, and Marshall is more persuasive than the above summary would suggest. Of course, even the original can be accused of deficiencies and lacunae; but if economic growth is the result of everything—which indeed it is—it is futile to complain of deficiencies when, as Lord Russell has remarked, the chain of causation may be traced by the enquiring mind from any given point backward to the creation of the world. And yet, though Marshall's is certainly a well-documented conception of economic growth, appearing to spring directly from the historical facts to which appeal is made, it does, in its general form and in some of its leading ideas, obviously derive from a style of thought and a system of preconceptions which are in some ways no longer fashionable and were never beyond the reach of criticism.

Marshall came to economics not solely through the study of his 'classical' predecessors such as Ricardo, but also through contact with the German historical school. It is recorded[29] that while in Germany in 1870 - 71 he came to know especially the work of Roscher, often regarded as the founder of that school; and his acknowledgment of indebtedness to Hegel is well known. The writers to whom he refers when dealing with large historical issues are almost exclusively German, chief among them being Hegel, Knies, Roscher and List, and the only Englishmen mentioned in such passages are Petty—whom it will be remembered Marshall regarded as 'classical'[30]—Bagehot, Buckle and Ashley—the last-named himself usually regarded as an adherent, if not a member, of the historical school.

Now this whole connection was, for Marshall's purposes, a very sympathetic one. For the aim of the German historical school was the

[29] J. M. Keynes in *Memorials of Alfred Marshall*, p. 11.
[30] *Ibid.*, p. 374.

discovery of laws of historical development. As Gustav Schmoller put it when writing of Roscher (and the words might be applied to any member of the school), ' He searches for natural laws which control the general process of economic development. The study of antiquity, the perusal of recent historical writing, the investigation of statistical data—all this serves him only as empirical material for the formulation of general principles relating to the march of political and economic history.'[31]

This programme originally derives from Kant's *Idee zu einer allgemeinen Geschichte in weltbürgerlicher Absicht,* published in 1784, and more directly from that work which Marshall ' a few weeks before his death dwelt especially on ',[32] Hegel's *Philosophy of History.* The whole idea of a generalised but historical theory of economic growth is thus taken over from the German historical school, and Marshall's concern with the problem, as compared with the unconcern of, say, Jevons or Edgeworth, is partly explained by his philosophical background. So, too, is the strikingly cosmopolitan treatment of the subject by Marshall—for did not Hegel hold that all true history is universal history ? And so is the idea that economic growth and human freedom may most intelligibly be seen as advancing hand in hand. ' What is the purpose of Nature in endowing man with reason? ' asks Kant in the *Idee zu einer allgemeinen Geschichte;* and he answers, ' Since Nature gave man reason and the freedom of will which rests upon reason, that serves to show clearly Nature's purpose. . . . By concentrating primarily on the civic constitution and its laws and on the relation among states, because both have served to raise up nations, their arts and sciences, one may discover a guide to explain the chaotic play of human affairs.'[33] Thus the way in which the earlier German historicists, and along with them Roscher, Knies and Schmoller, aimed to make sense of history was by picturing it as the march of freedom, the development of the moral reason of man as exhibited in an external system of social relations : this was the good. It cannot therefore surprise us to find that economic historians working within this philosophical tradition should have come to associate this good with the material good of economic growth in some kind of cause and effect relationship. Marshall thus became the advocate of personal freedom on another, in a sense deeper, level than Adam Smith ; and when he writes that ' complete political freedom and security enables everyone to adjust his conduct as he has decided that it is his interest

[31] Quoted in H. W. Spiegel, *The Development of Economic Thought* (New York, 1952), pp. 367-68.
[32] J. M. Keynes in *Memorials of Alfred Marshall,* p. 11, n. 1.
[33] Kant, *op. cit.,* 3rd and 9th Principles.

to do. . . . In short . . . the same causes [and] the same qualities which gave [England and her Colonies] political freedom gave them also free enterprise in industry and commerce '[34] we may suspect him of confounding a practical argument for *laisser-faire* with a philosophical argument for self-responsibility.

This then is the fundamental obligation of Marshall's argument to the historical school. There are other similarities. The insistence upon the importance of climate and geography for the development of national character is common property of the historical school, while the emphasis placed upon national character, and especially upon that ' capital stock of " moral wealth " which is the heir of the ages ',[35] and which America is described as having received from Europe, is particularly reminiscent of Sombart. And it is perhaps not entirely fanciful to suggest that the original arrangement of the *Principles,* with its historical section and its section on the development of doctrine preceding the corpus of theory, owes something to the identical sequence of Roscher's main works: *Economics viewed from the Historical Standpoint, History of Economic Thought in Germany,* and his *System of Economics.*

III

Although Marshall's ideas are developed within a framework supplied by the dominant traditional thought of nineteenth-century philosophy and history, his originality in working out his ideas of intermediate range—mostly those which we have called his major influences —is not to be denied. Indeed, in this part of Marshall's work the degree of independence of German historical ideas is surprising. For example, those economic institutions—the guild, the city, the partnership, the joint-stock company—upon which writers such as Roscher and Schmoller loved to dwell receive little mention ; even the development of financial institutions is allowed a very small rôle. It is also true that there is not much sociology, and this is in marked contrast with the concern of the historical school for ' cultural life ', ' the national outlook ', ' the stage of civilisation ' and so forth. Marshall tends to confine himself, in this part of his thought, to the more narrowly economic issues, just as he confines himself to the more specific problems—again in contrast to the generalising tendency of the German writers, especially of Sombart.

It is pertinent to ask, however, whether Marshall's own ideas have dated, in the sense of appearing valid for his age but invalid for the

[34] *Principles,* Book I, Ch. 3, sect. 3.
[35] *Industry and Trade,* p. 143.

problems of our own; or even in the sense of being generalisations from what now seems too narrow a range of historical experience. This is a question difficult to answer satisfactorily in a few pages. For it is always easy, although it is not often very profitable, to think of exceptions or apparent exceptions or partial exceptions to almost any general proposition involving human behaviour: as Schmoller once plaintively remarked, 'Natürlich ist nun aber die Einreihung der Erscheinungen in einem historischen Kausalzusammenhang nicht überall gleich möglich'.[36] Moreover, hunting historical exceptions is an intellectual pastime capable of almost indefinite prolongation. In these circumstances it seems best to concentrate attention on only three ideas in Marshall's set of major influences, three ideas which seem sufficiently precise and important for a brief criticism to be both possible and worthwhile.

First of all, there is 'Petty's great rule' according to which 'each country flourisheth in the manufacture of its own native commodities'—a proposition which so impressed Marshall that he referred to it in *Industry and Trade* in no fewer than four separate passages. Yet it is not altogether easy to acquiesce in the importance attached to this idea by Marshall, at least not without qualifications. At comparatively low levels of economic development Petty's statement is no doubt often true. Nevertheless, a distinguished authority on the medieval woollen industry remarks that 'the crucial fact about the two great manufacturing areas was that both were dependent on imported supplies'.[37] Similarly, Dutch shipbuilding, to which, following Petty, Marshall himself refers, was almost wholly dependent on imported timber, though it must be admitted that Holland was, so to speak, a natural entrepôt for much of the European timber trade and hence acquired an almost proprietary interest in the raw material. It is undeniable, of course, that both France and England made important economic progress prior to the eighteenth century through the working-up of home-produced wool. But the acceleration of economic growth in Great Britain after about 1750 was based, at least in part, on imports of raw cotton, and the same is true, though to a much smaller extent, of France. The woollen industry likewise expanded in both Britain and France in the nineteenth century on the basis of imported supplies. The 'rule' casts little light on the development of the United States, where native commodities are abundant, and not much on that of Australia, where they are relatively meagre. It also

[36] G. Schmoller, *Zur Literaturgeschichte der Staats- und Socialwissenschaften* (Leipzig, 1888), p. 156.

[37] E. Power, *The Wool Trade in English Medieval History* (Oxford, 1951), p. 12.

obscures the important fact that economic progress has relocated the sources of supply of many raw materials; wool was not originally produced in Australia, cotton in the United States, nor rubber in Malaya. It is the case, of course, that a country is likely to do well in working up those raw materials which, for it, bear no transport costs; but there are also forces which cause crude oil to be shipped half-way round the globe before it is refined. It may be true that concentration on working up native commodities is often the best policy for economies in a fairly primitive stage of development, especially if they find it difficult to obtain foreign capital. But Marshall does not make it clear that the validity of the proposition is limited in this way; yet if it is so limited, this fact is itself significant in the study of economic growth.[38]

We must take much more seriously the complex notion of 'massive production'. This figures more extensively in Marshall's writings than any other of his ideas concerning growth, and its validity, if established, would carry implications for several of Marshall's own theoretical contributions, notably for the idea of the 'representative firm'. But first it is important to be clear what is meant by massive production. Massive production is not a synonym for heavy industry or even for factory industry. It means, primarily, production for more than a local market on a scale requiring co-ordinated merchanting. The essentials are 'the power of organising great numbers of people' and 'a demand for whole ship cargoes of goods of a few simple patterns'.[39]

Two questions must be asked about the rôle of massive production in economic growth. The first concerns the way in which Marshall conceives the process to work; he habitually suggests that transport improvement precedes and overshadows technological change, and we must ask whether this is justified. Secondly, there is the question, 'Is it true that massive production is so commonly the means to national prosperity as Marshall seems to suggest?' Let us take these two questions in that order.

Marshall's most precise statement of the relation between the demand for and supply of improved transport is, at best, elliptical. Speaking of eighteenth-century England, he says: 'The demand for good roads came rather from the general quickening of agriculture and of urban industry, than from concentrated manufacture for

[38] Marshall does concede, in *Industry and Trade*, p. 167, that 'economic progress has at last undermined some of the foundations of Petty's great rule', but his statement is chiefly a reaffirmation of a different point, namely, the importance of the existence of extensive and assured markets.

[39] *Principles*, Book I, Ch. 3, sect. 4. It must be admitted that massive production is a rather unfortunate way of describing what Marshall had in mind since it must include both light industry and handicraft industry.

export.'[40] This is all, and the causes of the 'general quickening' are not stated. Against this must be set the authoritative opinion of Mantoux. There are three parts to Mantoux's argument. First of all he stresses the pioneering initiative of the overseas merchants: 'It was maritime trade which gave them wealth and made them ambitious. . . . These men, who were constantly travelling to the remotest corners of the country, and were in touch with the continent and America, kept forcing the manufacturers to increase their production and improve their methods. Later, they supervised production themselves.'[41] This agrees with the stress laid by Marshall[42] on the importance of pre-industrial capitalistic experience; but it places heavy emphasis on the initiatory rôle of foreign trade where Marshall seems to place little. Secondly, Mantoux stresses, undoubtedly correctly, the peculiar importance for the quickening of industry and the improvement of transport of one particular technological innovation—the increasingly widespread use of coal in industry. Thirdly, Mantoux holds that actual improvements in transport were undertaken either by business men aiming to lower the price of their goods in markets already known but expensive to reach, or else by property owners aiming to raise the value of their property, or by both.

So much for the eighteenth century. If, however, we turn to the nineteenth century the case is not so clear. For the period of the railway age Cunningham took the opposite view from Marshall: 'The staple industries of the country had been revolutionised by the introduction of machinery, before serious efforts were made to bring inventive power to bear on improving facilities for transport within the country and by sea.'[43] This is, at any rate, a possible view. But after 1850 matters grow more complicated. One great transport improvement, the use of refrigeration at sea, was more properly speaking a technological advance; what is more, it was one promoted by government,[44] and it was intended to make possible the invasion of a new market and not merely the better securing of an old one. When we examine the great cheapening of rail and sea transport which so dominated Anglo-American economic relations between 1850 and 1900, we find that railroads frequently partook of the nature of speculative improvements, going ahead of trade and creating and opening up new markets, although they were also clearly cost-reducing, while

[40] *Industry and Trade*, p. 39.
[41] P. Mantoux, *The Industrial Revolution in the Eighteenth Century* (London, 1934), p. 106.
[42] Cf. p. 5.
[43] W. Cunningham, *Growth of English Industry and Commerce* (Cambridge, 1917), Vol. III, p. 811.
[44] See G. R. Scholefield, *New Zealand in Evolution* (London, 1909), pp. 127-29.

the development of iron and steel steamships was partly the result of competition for business, national and international, and partly the result of technological improvements in the engineering and steel-producing industries.

In short, the relation between transport improvements and technological improvements is complicated and unpredictable. It would appear that economic growth is encouraged either when new economies of production are realised and an expanded output puts pressure on existing transport facilities, or equally when innovations within the field of transportation show the cheaper carriage of goods to be possible. Of course if transport shows economies of scale as well as industry the benefit is likely to be all the greater, and this was clearly the case in the nineteenth century ; and it is always true that any such changes, once begun, may react upon one another over a considerable period.

Turning now to the second question, we may ask what proof there is that massive production is the only or even the commonest road to economic prosperity? The answer depends to some extent on whether massive production is to be regarded as a generic term covering *all* capitalistic enterprise coupled with non-local markets, or whether it excludes large-scale factory production. If it does not exclude the latter, then Marshall's proposition receives strong and obvious support from British and American experience in the nineteenth century. The progress of the cotton industry, where plants grew little in size after about 1850, might have suggested to an observer the importance of external economies. The progress of the steel industry during Marshall's most active years as an economist (say from 1880 to 1900) was beyond question an object lesson in the economies, both internal and external, of large-scale production. The 'firm' structure of the British steel industry became in these years an acknowledged bar to progress.[45] Of seven 'conspicuous contrasts'[46] detected by Burn between British and rival development in the years 1880 - 1905, four relate to the scale of production, the British being uniformly the smaller ; and everyone knew that the British industry was both technically and economically behind its rivals.[47] Such examples might be multiplied. Marshall's interest in American economic concentration, and what looks rather like his approval of it,[48] comes in here too ; the economies of large-scale concentrated production were conspicuous, and fortunes were made in oil, meat packing and farm machinery.

[45] See D. L. Burn, *The Economic History of Steel Making, 1867-1939* (Cambridge, 1940), pp. 190 *et seq.*

[46] *Ibid.*, p. 220.

[47] For a masterly examination of the reasons *why* the British industry did not achieve more economies of scale, see Burn, *op. cit.*, Ch. 12.

[48] Cf. p. 4.

Certainly, a high standard of living and massive production in this sense were often to be found together in the nineteenth century.

But what of the development of Italy and Flanders in the Middle Ages? Or of any pre-industrial economy? The answer lies in reverting to the interpretation of massive production which is more narrowly in accordance with what Marshall wrote. For if by massive production we understand extensive concentration of effort on certain lines of output, without, necessarily, any high degree of capitalisation or concentration of economic power in a few plants or a few hands, then Marshall's argument remains convincing, and has grown, perhaps, even more convincing since Marshall's middle age. Here, indeed, lies the real originality and importance of the idea. Take, for example, a country which Marshall knew well, and to which he frequently refers —Switzerland. One hundred and fifty years ago Switzerland was a comparatively poor country ; today she is one of the wealthiest in Europe. This is not simply a matter of the tourist trade. Swiss prosperity was built up on what were originally handicraft industries such as embroidery and watch-making. Subsequently, light engineering industries and certain branches of the chemical industry were developed. In each case the country is producing goods where either quality of workmanship or volume of demand does not make production by very large units economical ; but clearly there are economies of national specialisation.

The case of Sweden is not dissimilar. About 1850 or 1860 Sweden began to emerge from her economic eclipse—largely brought on by Britain's industrial revolution—along lines very consonant with some of Marshall's ideas, by liberating and redeveloping her iron industry, based on native ores, and by building up a trade in timber and subsequently in wood products. Next she went on to develop light industry on an extensive scale ; and by 1914 Sweden was an important exporter of high-class engineering products such as ball bearings, cream separators and electrical machinery, in addition to certain handicraft products such as furniture and glass-ware. The Swedish advantage in these forms of output lies primarily not in the size of the productive units, but in the fact that production is undertaken on a scale suitable for, and with continual reference to, international markets. Equally instructive, there is the case of New Zealand, a country with one of the highest standards of living in the world. New Zealand is devoid of heavy industry, and, although possessing some light industry, is critically dependent on exporting the products of a highly developed agriculture. This is a case of massive production in agriculture, and it contains, naturally, many unusual features. But New Zealand's success

in achieving a high level of income per head by such means is not so remarkable as seems sometimes to be thought.

Instances of economic growth being achieved without much industrialisation are easy to find if growth is studied on a regional instead of a national basis. In a world in which international trade takes place the economic distinction between regions and nations is not absolute ; and it is the less absolute the more freely goods and services and the factors of production pass national boundaries, and the more stable are the trading arrangements of nations. Even excluding such considerations, it may still be argued that conditions in the countries mentioned above were peculiar : Switzerland and Sweden have cheap electric power, and New Zealand has exceptional climatic advantages. This is true ; but in what cases are conditions not, in one respect or another, peculiar? 'Aber, meine Herren, es ist alles so unendlich compliziert.'[49]

IV

Marshall's attempt to understand economic growth as a general phenomenon is long-range and fundamental. It is not an attempt to explain the relationship between secular growth and cyclical fluctuations in output, nor is it an attempt to understand why growth takes place at particular rates. It does not, like much modern discussion, begin by taking growth for granted ; it asks the prior question, ' Why is there growth at all? ' Marshall's answer to this question—and the loose formulation of his answer prevents us from describing it as a system—does not turn out, on examination, to be as original as it at first appears. Its framework is provided by the general ideas of the German historical school. Of course this does not condemn it out of hand. It is true that, even if philosophical ideas about history had not changed, the solitary fact of the economic history of the U.S.S.R. would compel us to reject too simple notions concerning the connection between personal freedom and economic growth ; on the other hand, there may be much truth in some of the other general arguments put forward by Marshall such as that one climate may be more favourable for economic growth than another—even though Sombart said so.

The core of Marshall's analysis, however, is the part which we have described as being of intermediate range, and here the crucial idea concerns massive production. What Marshall says in this connection is extremely suggestive, especially if we do not slip into a misunderstanding of what is meant by massive production. His treatment of this topic is highly original, although what he says is not, in

[49] Schmoller, quoted by Gay in ' The Tasks of Economic History ', *Journal of Economic History*, 1941, Supplement, p. 13.

some respects, fundamentally new. Disregarding the relationship, already discussed, between innovations in transport and in industry, Marshall's thesis is the almost platitudinous one that economic growth is promoted by the lowering of costs, and that the most important class of industrial economies are those of scale. This is almost exactly the argument of Adam Smith. A great part of *The Wealth of Nations* is devoted to an examination of the causes and preconditions of economic development, and one of the three main causes listed is the division of labour ; the other two are the accumulation of capital, and the way in which capital is employed. The division of labour is put in the forefront because Smith credits the workman himself with the invention and improvement of many labour-saving devices ; and this was probably valid enough for Smith's own times, when improvement of capital instruments was largely a matter of technical ingenuity —especially in the textile industry—and when the amount of capital per worker was small. But basically the two propositions, Smith's and Marshall's, are clearly alike : an extension of the division of labour and a ' drift towards massive production ' are two ways of looking at the same thing, the first appropriate to a less, and the second to a more highly-organised and technologically-advanced economy ; and in each case the argument is that greater scale of production is the most effective means of lowering costs. Even with regard to international trade the two writers do not develop the idea very differently. Thus Smith wrote : ' As by means of water-carriage, a more extensive market is opened to every sort of industry than what land carriage alone can afford it, so it is upon the sea coast, and along the banks of navigable rivers, that industry of every kind begins to subdivide and improve itself ; '[50] and again : ' Merchants are commonly ambitious of becoming country gentlemen, and when they do, they are generally the best of improvers. A merchant is accustomed to employ his money chiefly in profitable projects ; whereas a mere country gentleman is accustomed to employ it chiefly in expence. . . . A merchant is commonly a bold, a country gentleman, a timid undertaker.'[51] This agrees with Marshall's own references[52] to the advantage of a maritime economy, although it is stronger and more precise. On the other hand, Marshall throughout his writings attaches much more importance than Smith to the organising ability and initiative of the entrepreneur.[53]

[50] Smith, *op. cit.*, Book I. Ch. 3.
[51] *Ibid.*, Book III. Ch. 4.
[52] Cf. p. 2.
[53] The essential difference between the two writers is that Marshall associates the division of labour with internal economies, and connects external economies, which he regards in some ways as the more important, with massive production.

The comparison with Smith suggests another criticism. Marshall dwells on the importance of ' extensive markets ' which can be opened up only if transport costs are lowered. This conception of expansion suits the experience of the eighteenth and nineteenth centuries, when there were in numerous countries, especially in the East, markets waiting to be reached by modernised transport. The point is, however, that the markets were already there ; goods could readily be sold simply by taking trade away from home producers. And one of the reasons why this course was available to Great Britain was a non-economic one, namely, that ' the long-continued efforts to build up the maritime power of England had been crowned with success '.[54] The conception of Adam Smith is much more dynamic ; as Allyn Young interpreted it, ' the division of labour depends upon the extent of the market, but the extent of the market also depends upon the division of labour '.[55] All demand is mutual demand, and expansion by one industry is a demand for and is dependent upon expansion by another. Solitary expansion, either by one industry or by one country, is not impossible, but it is difficult. Economies, to be truly effective, must be made on a broad and not on a narrow front. Thus nothing can be concluded from the fact that the twentieth century cannot find, as the eighteenth and nineteenth centuries did find, markets waiting to be reached ; for we may hope that they can be made. This seems to be Smith's idea ; it is Young's certainly. In one way it makes Marshall's argument appear static and unconvincing when he says that the time must come when ' improvements in transport will count for little. From that time onward the pressure of the Law of Diminishing Return can be opposed only by further improvements in production ; and improvements in production must, themselves, gradually show a diminishing return.'[56]

On the other hand, if this argument is held to apply to diminishing returns in terms of raw produce for countries predominantly industrial, and if it is held that superior organisation has not the power to expand agricultural production that it has to expand industrial production, then it is both valid and of great importance in that it sets a limit to the rate and extent of economic growth.

This interpretation is probably the correct one ; for Marshall's analysis is above all things dynamic. It is also flexible and undogmatic. Moreover, the range of Marshall's historical reference provides empirical proof for many of his ideas in forms so diverse that we are

[54] Cunningham, *op. cit.*, p. 610.
[55] Allyn A. Young, ' Increasing Returns and Economic Progress '. *Economic Journal*, 1928, p. 539.
[56] *Memorials of Alfred Marshall*, p. 326.

forcibly reminded that economic growth can take place in an infinite variety of ways. This raises grave difficulties both for analysis and for policy. Should we assume, for example, that the so-called ' problem of economic growth ' is one and indivisible, and that the process of pioneering economic advance is a useful model for those who aim—at a rate which would make most nineteenth-century experience seem tame and pedestrian—to fit themselves into a prosperous world? And is it helpful to assume that economic growth and industrialisation are interchangeable terms? It is true that agricultural growth has always been accompanied either by industrialisation elsewhere or by improvement of access to already industrialised markets. But this does not prove that industrialisation is an essential precondition of agricultural progress ; it rather suggests that, basically, the process of economic growth is, as Adam Smith and Marshall both said in their different ways, one of increasing specialisation and the widening of markets.

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ELECTRICITY IN THE NORTH OF SCOTLAND

THE aim of the following paper is to assess the success of the policies followed by the North of Scotland Hydro-Electric Board in supplying the North of Scotland with electricity. In particular we raise the question of the cost of electricity, and of how far the policies followed are justified as compared with alternatives which have been available.[1]

I

EXPANSION

The capital investment programme of the North of Scotland Hydro-Electric Board has radically changed the character of many parts of the Highlands, and has had wide repercussions on many aspects of life. From Table I it will be seen that, over the six years 1949 to 1954, capital investment has averaged £14 m. per year, though it has

TABLE I

INVESTMENT BY THE NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD, 1949 - 54

	Generation		Transmission	Distribution	Other	Total[1]
	Hydro	Other				
	£m.	£m.	£m.	£m.	£m.	£m.
Assets at 31st December 1948	11·8	0·6	1·6	1·5	0·3	19·6
Acquired assets at 31st December 1949	3·3	1·7	0·7	6·7	0·1	12·5
Annual investment						
1949	*10·6*	*0·1*	*1·2*	*1·9*	*0·2*	*13·4*
1950	*10·5*	*0·4*	*1·0*	*2·7*	*0·2*	*12·2*
1951	*6·9*	*0·3*	*1·1*	*2·9*	*0·2*	*11·4*
1952	*8·8*	*0·4*	*1·3*	*3·3*	*0·1*	*13·6*
1953	*11·4*	*0·1*	*1·3*	*3·1*	*0·1*	*15·9*
1954	*14·8*	*0·2*	*1·3*	*3·5*	*0·1*	*19·9*
Total 1949-54	63·0	1·5	7·2	17·4	0·9	86·4
Total capital 1948-54	78·1	3·9	9·5	25·6	1·2	118·5

[1] Total capital expenditure includes expenditure not allocated to particular sectors in a given year, but added perhaps in the next year. This explains why, at 31st December 1948, assets as distributed to particular sectors are nearly £4 m. less than total assets, whereas total capital expenditure between 1949 and 1954 is nearly £4 m. less than sector investment. The annual figures for each sector do not therefore clearly measure the actual volume of investment in that sector in that year.

[1] I am grateful for information kindly supplied by the Board on a number of points.

fluctuated considerably as a result of changes in the Government's investment policy. In general, capital expenditure on generation represents about two-thirds of total capital expenditure, that on distribution about a fifth, and that on main transmission less than a tenth.

The purpose of this vast expenditure by the Board has been to expand the production and consumption of electricity in the area. In this task the Board has been outstandingly successful; what is more in question is the cost of this success, and how far it has justified itself.

TABLE II

INDICES OF EXPANSION, 1949 - 54

	North of Scotland Hydro-Electric Board			British Electricity Authority
	1949	1954	1954 as % of 1949	1954-55 as % of 1949-50
Total generating capacity (KW. installed at end of year)	250,970	594,372	237	153
Hydro-electric capacity (KW. installed at end of year)	86,915	431,385	496	...
Million units generated	710	1,566	220	152
Million units generated by water power	322	1,183	368	...
Million units sold to customers in area	511	901	176	149
Million units sold to B.E.A.	56	390	693	...
Total sales[1] (m. units)	594	1,333	224	150
Domestic sales (including crofts)[2]	206	366	178	136
Commercial sales[2]	103	186	181	165
Farm sales[2]	15	60	399	260
Industrial sales[2]	163	267	164	152
Consumers connected at end of year (thousands)	222·2	322·1	145	118
Consumption per consumer (units)	2,301	2,797	122	127

[1] Including units used in construction schemes.

[2] Commercial sales include 'Shops, offices, business, commercial and public premises' and 'Hotels and boarding houses' for the Board, and 'Commercial' for B.E.A. Industrial sales include 'Factories and workshops' and 'Waterworks and drainage pumping stations' for the Board, and 'Industrial' for B.E.A. They exclude units used in construction. Owing to reclassification, 'Domestic' and 'Commercial' sales for B.E.A. are not exactly comparable in the two years. B.E.A. years run to 31st March.

Total generating capacity more than doubled from 1949 to 1954, and hydro-electric capacity in 1954 was six times as great as in 1949. The output of electricity has more than doubled, and the output of hydro-electricity has nearly quadrupled. Sales of electricity to consumers in the area have increased by 77 per cent., and sales to farmers have grown fourfold. At the end of 1948 there were about 200,000 consumers connected to electricity mains, and about 320,000 at the end of 1954—about 20,000 new consumers having been connected every year. There remain only about 70,000 consumers in the area to be connected, though it will be increasingly difficult to serve this residue. At the end of 1954, 44 per cent. of all farms and crofts were connected with electricity. This figure is not as high as the 60 per cent. coverage of farms in the British Electricity Authority's district, but represents a great achievement when the differences of terrain are considered. In the last few years the Board has been connecting farms and crofts at the rate of over 3,000 per year, whereas the B.E.A. has been connecting over 12,000 per year in a much larger area.[2]

The expansion of the Board between 1949 and 1954 is compared with that of the British Electricity Authority in Table II. In this period B.E.A. expanded its capacity, its output and its sales by about 50 per cent., compared with an increase of about 120 per cent. by the Board. In every separate sector, the Board's sales expanded more rapidly than B.E.A.'s,[3] though customers have not expanded their use of electricity so quickly. The relatively fast expansion of farm sales in the North of Scotland is particularly noticeable.[4] All in all the Board has shown great vigour, and has been highly successful in its expansion policy. But the question of costs still remains.

II

Costs

Generation Costs

The costs of the different methods of generating electricity in the North of Scotland district are very diverse, and there is a wide gap between the cheapest method, hydro-electric generation, and the dearest,

[2] B.E.A., *7th Report*, 1954-55, pp. 48-9. From 1st April 1948 to the end of 1954, the Board connected 41.5 per cent. of unconnected farms and crofts compared with B.E.A.'s 36·5 per cent.

[3] In the case of commercial sales, B.E.A.'s figures may be misleading in view of the reclassification of domestic and commercial sales.

[4] But sales per farm customer, though nearly one-third higher than in the rest of Britain, have expanded much less rapidly. On the other hand, the Board's domestic sales per consumer expanded faster than B.E.A.'s.

diesel generation. The figures are given in Table III.[5] In 1949 hydro-electric costs were less than a quarter of diesel costs, and just about a third of steam generating costs. But since then the position has become less advantageous to hydro-electric power. Hydro-electric costs were as high as two-thirds of steam costs in 1953, and even in the very favourable year 1954, the ratio of hydro-electric to steam costs was higher than in 1949. In other words, whereas steam generating costs had risen by only a third and diesel costs had doubled during the period, hydro-electric costs were more than twice as high as in 1949 ; and they had been two and one-third times as high in 1953. To understand this, we must analyse the various costs more closely.

TABLE III

COSTS OF GENERATION, 1949 - 54

Year	Units generated			Generation costs per unit			Average costs of generation and purchase of electricity
	Hydro-electric	Steam	Diesel	Hydro-electric	Steam	Diesel	
	Millions	Millions	Millions	d.	d.	d.	d.
1949	322	320	68	·2178	·6357	·9277	...
1950	522	284	72	·2504	·7254	1·3699	·4810
1951	702	318	61	·3647	·7170	1·7172	·5415
1952	889	296	52	·4166	·8113	1·9544	·5761
1953	914	364	55	·5171	·7907	1·8912	·6490
1954	1183·5	328	55	·4558	·8417	1·8580	·5862
1954 as % of 1949	368	103	81	209	132	200	...

Hydro-electric Generation.—The costs of hydro-electric generation are very largely capital costs. In 1949, interest and redemption costs were £224,000 out of total generating costs of £292,000 ; in 1954, total generating costs had risen to £2,248,000, and interest and redemption costs had risen to £2,083,000. The two other items of cost—repairs and maintenance, and the wage cost of operation—were insignificant in relation to these costs ; but operating wage costs had risen four-fold from £18,000 to £78,000, whereas repairs and maintenance had risen by only about 50 per cent. from £49,000 to £73,000.[6] The output of power from hydro-electric schemes in 1954 was three and a half times greater than in 1949, and total interest and redemption costs

[5] They are figures of total average costs (net of sale of by-products) per unit generated ; units used in generating stations or later lost in transmission and distribution are included.

[6] These figures are not exactly comparable for the two years, but the differences are minor.

nearly ten times what they had been. It is thus clear that capital charges have been the main items causing the increase in the cost of hydro-electricity.

The Board has borrowed a total of £107 m. in the period of rising interest costs since 1947: £20 m. were borrowed at 4¼ per cent., £20 m. at 4 per cent., another £40 m. at 3½ per cent., and only £27 m. at 3 per cent. or less. The average interest cost on borrowings up to 1954 was 3·6 per cent. If interest charges had been only 3 per cent., the saving would be £625,000 per year on the actual cost of nearly £4 m.; if only 2½ per cent., £1,160,000 would be saved per year. As can be seen from Table I, about two-thirds of the total cost arises from capital expenditure on hydro-electric generation; it follows that if interest charges were at 3 or 2½ per cent. the saving would be about £420,000 or £770,000 per year. These savings are to be compared with total generating costs in 1954 of just over £2 m.[7]

The fact that interest costs are such a large proportion of the cost of hydro-electricity means that special care must be taken to see that these schemes justify themselves on an economic basis. Capital has been scarce in most of the post-war years, and high rates of interest measure the scarcity of capital, though in fact the Board has not had to borrow at very high cost. The charging of these interest costs to consumers enables us roughly to measure *ex post* whether the investment has been wise or not. We can examine in this case the relative cost of current to consumers, standards of comparison being available in the costs of the B.E.A. and the prospective costs of nuclear energy. In post-war Britain, capital invested to bring in a return of 3·6 per cent. should have enabled consumers to obtain increased output at a low price; many industries in which the return was far higher than 4 per cent. have been short of capital. It is all too readily assumed that because *some* investment in public projects, such as hydro-electric development or forestry, is justified, the expenditure of every sum of capital that the technical experts can lay their hands upon is equally justified. We must ask whether the expansion of hydro-electricity in the North of Scotland justifies its use of scarce resources.

The rise in interest costs per unit of output is due to a variety of factors, as well as to the rise in interest rates. (1) With a rapidly expanding investment programme, expenditure is incurred before it comes to fruition in terms of increased output. (2) In 1949, more than 90 per cent. of the hydro-electric output came from the two large pre-war schemes at Rannoch and Tummel Bridge, whereas by 1954

[7] There is no gain to the Board from investment of its redemption funds at higher rates of interest, because it uses its funds for its own capital expenditure (and, incidentally, charges itself well below the market rate). Our figures represent the net cost of outside borrowing.

these accounted for less than one-third of the total.[8] Inflation has considerably reduced the real incidence of the capital costs of these schemes, and of those built just after the war. (3) Apart from inflation, real capital costs per unit of output have risen as less fruitful schemes have been brought into operation.

A statement of capital cost per KW. of installed capacity, as is usual in the case of steam stations, is meaningless in the case of hydro-electric power stations. The output of a steam station is limited by its capacity, the maximum being 8,760 (365 × 24) KW. H. per year per unit KW. capacity if it is run to theoretical full capacity. A more normal output for a station used as a base-load plant would be 80 per cent. of capacity, or 7,000 KW. H. per year per unit KW. capacity.[9] In the case of hydro-electricity, the limit is set by the usable water power available, which will be larger in a rainy year than in a dry year. Water power can be stored, as electricity cannot, so that the best rough measure of the capacity of a hydro-electric scheme is provided by the average annual output expected from it. The way this output is used is a matter of choice, and is partly determined by the KW. capacity installed. As the cost of installing extra KW. capacity for a given annual output does not rise commensurately,[10] there is often an advantage in using a hydro-electric scheme as a peak-load station capable of producing a very large proportion of its total potential output in a short period. Such stations will be designed to work at a very low load-factor (average annual output per KW. capacity), or what we will call a very low 'gearing'. Only three of the Board's stations of any size are designed to work at more than an equivalent of 50 per cent. capacity (4,380 KW. H. per year per unit of KW. capacity). The Sloy scheme, the first initiated by the Board, which was designed to make profits from the export of peak-hour electricity, has a very low gearing of only 920 annual units per KW. The highest gearing is to be found in the Torr Achilty station (5,450 annual units per KW.).[11]

[8] Producing at less than ·2d. per unit. *Report*, 1952, p. 60.

[9] Strictly 7,008 KW. H. Of the twenty most efficient B.E.A. steam stations in 1954-55, only six were operated at more than 80 per cent. of capacity. *Report*, 1954-55, Appendix 19.

[10] The Board calculates that to double capacity at a station costing £250 per KW. installed might cost only £40 per extra KW.

[11] This point does not always seem to have been appreciated. Thus R. S. Hutton and O. W. Roskill, 'The Electro-Metallurgical and Electro-Chemical Industries' (reprinted from *Engineering*, 5th and 19th May and 2nd June 1939), compared steam and hydro-electric costs in terms of capital costs per installed KW., and assumed both stations to be working at 80 per cent. of capacity. They do not seem to have been aware of the oddity of the comparison, though it was quite reasonable from the point of view of the supply of electricity in bulk to the chemical industry.

If we want to compare steam and hydro-electric initial capital costs, we must relate them to the number of units generated per year. This is constant for a given hydro-electric scheme, but varies in the case of a steam station according to the load-factor. For a base-load station working at 80 per cent. load-factor, and producing 7,000 units per annum per KW. of installed capacity, capital costs of £50 per KW. amount to about £7 per thousand units per annum, whereas for a similar station dealing entirely with extreme peak loads—11 per cent. load-factor, one thousand units per annum per KW.—they will amount to £50 per thousand units. The Sloy scheme was designed with an installed capacity of 130,000 KW., and its estimated cost was £4·1 m. or £32 per KW.[12] Compared with a steam station planned at the same time, which might have cost about £50 per KW., it may seem cheap; but the Sloy scheme was designed to produce only an average of 100 m. units per annum, with a very low gearing of 770 units per KW. Capital costs per thousand units per annum work out at £41, six times the cost of a base-load steam plant costing £50 per installed KW. but lower than the cost of a peak-load plant.[13]

Actual capital costs for completed hydro-electric stations are not available, but estimates have been published for most of the Board's development schemes, and it is believed that, apart from price rises, these have not been far from the actual costs incurred. Seven schemes approved in 1944-46 had estimated costs varying from £12 to £42 per thousand units per annum.[14] Nine schemes approved in 1947 and 1948 had costs varying from £29 to £44 per thousand units. By the winter of 1950-51 prices had risen, and costs in schemes varied from

[12] Cmd. 6596, *North of Scotland Hydro-Electric Board Constructional Scheme No. 1. Explanatory Memorandum* (H.M.S.O., Edinburgh, 1945). The details of the actual scheme are not quite the same.

[13] The capital costs would be the same if the steam plant produced 1,220 units per KW. per annum, *i.e.* roughly a 14 per cent. load-factor. This comparison is not meant to suggest that we can compare the capital costs of steam and hydro-electric stations so simply, but merely to illustrate where the comparison must start, before taking account of the life of plant, etc.

[14] Costs per installed KW. varied from £32 to £95. To illustrate the irrelevance of the cost per KW., we can compare the Gairloch scheme (£92 per KW.) with the Tummel-Garry scheme (£41 per KW.). The former has a high gearing (5,000 units per KW.), and the latter, designed for the export of electricity to the south of Scotland, particularly at peak hours, has a very low gearing (2,000 units per KW.). The cost per thousand units per annum for the two schemes was £18 for Gairloch and £21 for Tummel-Garry. (The details given are from the explanatory memoranda on the schemes, published as Command Papers. They refer to the schemes as designed, and not necessarily as carried out.) Hutton and Roskill, *op. cit.*, estimated pre-war costs at £35 per installed KW. (80 per cent. load-factor), *i.e.* £5 per thousand units per annum.

£42 to £60. By early 1955 costs had risen again, by about 40 per cent., and in three schemes in 1954-55 they varied from £72 to £112.[15]

Steam Generation.—Electricity is generated by steam in the Aberdeen and Dundee stations, which are normally in substantial operation.[16] The costs of steam generation are given in Table IV. Both stations are to some extent used as standby stations to meet alterations in the current available from the hydro-electric schemes. This raises costs per unit, as can be seen from the fall in works cost between 1952 and 1953, when both stations were used extensively, in spite of the increase in coal prices by 4s. and 5s. per ton. Between 1950 and 1951 works cost and fuel cost both fell at the more efficient Dundee station, in spite of a rise in coal prices of over 5s. per ton. Marginal costs are lower than average costs for a rise in output, because many items of works cost are 'overhead'. This also applies to fuel costs: marginal fuel costs at Aberdeen in 1953 were ·562d. per unit compared with average fuel costs of ·703d.; at Dundee they

TABLE IV

STEAM GENERATING COSTS, 1949 - 54

Year	Aberdeen			Dundee		
	Units generated	Costs per unit		Units generated	Costs per unit	
		All works	Fuel[1]		All works	Fuel[1]
	Millions	d.	d.	Millions	d.	d.
1949	146·0	·619	·512	169·4	·501	·415
1950	144·9	·652	·559	136·2	·592	·471
1951	118·2	·763	·602	198·8	·554	·464
1952	113·2	·845	·689	182·1	·639	·520
1953	141·0	·834	·703	222·2	·633	·548
1954	111·5	·913	·726	215·7	·671	·557

[1] Fuel cost includes costs of handling.

[15] The rise in costs by 40 per cent. can be estimated from figures given for the Breadalbane scheme (Cmd. 8740 and Cmd. 9486), where costs rose from £50 per thousand units per annum, as approved in February 1951, to £71 in February 1955 for the same work. This suggests that the 1954-55 schemes were less fruitful, as a 40 per cent. rise in prices would raise 1950-51 costs from £42-60 only to £59-84. (Only one of the 1950-51 schemes cost £42; the five others cost from £50 to £60.)

[16] A small quantity of electricity was formerly generated at Arbroath, Wick, Waterloo (Inverness) and Perth; but all these stations have either been shut down or are used only occasionally during peak-load periods for generating insignificant quantities of electricity.

were ·343d. and ·519d. in 1951 and 1953 respectively compared with average fuel costs of ·464d. and ·548d.[17]

A comparison of steam generating costs in the North of Scotland area with those in the rest of the country is made in Table V. Each item of cost is higher in the North of Scotland, except for ' Oil, water and stores '. The gap has increased from 1949 (·11d. per unit) to 1954 (·23d.),[18] mostly owing to the increase in the difference in fuel costs from ·08d. to ·16d. per unit. In 1954 the cost of coal, excluding handling, was £3 6s. 2d. per ton for B.E.A., and £3 16s. for the Board; this difference of 10s. per ton (15 per cent. of the B.E.A. price) is clearly of great importance, and represents relative distances from the coalfields.[19] But at the same time the difference in fuel costs must

TABLE V

STEAM GENERATING COSTS IN THE NORTH OF SCOTLAND AND THE REST OF BRITAIN

(Pence per unit generated)

Item	1949		1951		1953		1954	
	Board	B.E.A.[1]	Board	B.E.A.[1]	Board	B.E.A.[1]	Board	B.E.A.[1]
Fuel (including handling)	·468	·385	·520	·425	·609	·451	·615	·457
Operation—salaries and wages	·050	·031	·055	·032	·044	·034	·051	·034
Oil, water and stores	·003	·004	·003	·003	·002	·003	·002	·003
Repairs and maintenance	·052	·041	·069	·039	·066	·037	·096	·037
All works cost	·572	·460	·647	·500	·721	·525	·764	·531

[1] B.E.A. published figures in terms of units supplied (sent out) have been adjusted to units generated. (The difference is accounted for in terms of units used in power stations.)

[17] Marginal fuel costs equal the change in tons of fuel used from year to year divided by the change in units generated, valued at the coal costs of the later year. The calculation is rather rough, as no adjustment is made for changes from year to year in efficiency or in stocks of coal; *e.g.* from 1949 to 1950 there was an increase in coal used at Aberdeen in spite of a fall in output. For what they are worth, the Aberdeen figures show marginal fuel costs above average fuel costs for a fall in output; and the Dundee figures show them below average costs for 1949-50, above for 1953-54, and more or less equal for 1951-52.

[18] But the increase has not been continuous.

[19] Even at Dundee, coal (including handling) cost 2s. 6d. per ton more than to B.E.A. in 1954. The difference at Aberdeen was 14s. 6d.

represent the fact that the Aberdeen and Dundee stations are relatively small and not very up-to-date, and the gap will widen as B.E.A. brings into operation more efficient stations. Seventy per cent. of the total output from B.E.A. steam stations in 1954-55 came from stations with fuel costs lower than ·5d. per unit sent out,[20] and a further 19 per cent. had fuel costs below ·6d., so that very little of the electricity generated by steam by B.E.A. was produced at fuel costs even as high as those at Dundee.[21] The higher expenses in the North of Scotland in practically every category suggest that the steam plant is not very efficient by B.E.A. standards.

Diesel Generation.—Diesel stations are a suitable method of providing outlying areas with electricity, where the demand is not large. They are very expensive, as can be seen from Table III, but they produce only small and declining quantities of current.[22]

Distribution Costs

Electricity is of no use at the point of generation ; it has to be provided where the customer is to use it. In the case of hydro-electricity, the point of generation may be very far removed from the point of consumption so that losses of current are high.[23] It is not therefore proper to compare the costs of generating electricity in the remote Highlands, where it is not wanted, with the costs of generation in Aberdeen, for example, where only a local network of mains is required.

The figures in Table VI show a tenfold increase in transmission costs per unit sold, which have a not inconsiderable effect on the general rise in costs though transmission costs still remain only a small part of total costs. But this does not give an entirely fair picture of the incidence of these costs. At the moment they are spread over the total sales of electricity, but, in so far as current is provided from local steam and diesel stations, consumers who use this current could properly be excluded from bearing these costs. In 1953, 1,150 m. units were sold in all by the Board, and 360 m. units were generated

[20] Costs per unit generated would be still lower.

[21] B.E.A. *Report*, 1954-55, Appendix 18. In 1949 the average cost of transport of coal to the various B.E.A. regions varied from 5s. 5d. to 15s. 6d. per ton, *i.e.* by more than 10s., and the gap must now be more, so that the extra cost of coal in the North of Scotland cannot be of so much importance in relation to other factors. (Figures of coal costs are from D. P. Sayers and P. W. Cash, 'The Basis for Extra-High-Voltage Developments in Great Britain', *Report of the Conférence Internationale des Grands Réseaux Electriques à Haute Tension*, 1952.)

[22] All the stations involved are small, and the largest at Kirkwall and Wick produced rather less than 12 m. units in 1954. Many of them will be superseded by hydro-electric schemes.

[23] *Report*, 1951, p. 16.

at Aberdeen and Dundee. If total transmission costs were spread over 790 m. units, costs per unit would rise from ·1109d. to ·1613d., and the relevant costs in Aberdeen and Dundee would fall by ·1109d.[24] Clearly this would not make an enormous difference.

A similar problem arises in relation to distribution costs. It is not entirely clear how far the expansion of expensive distribution systems in outlying areas is being subsidised by consumers in urban areas. Capital expenditure on distribution per new consumer has risen from £120 per year in 1949 to £184 in 1954. To some extent this is due to the rise in prices of materials, but it also includes the increased cost of connecting outlying customers, and the Board anticipate a continued rise in distribution costs for this reason.

All Costs

In Table VI all costs are shown and compared with the costs of the B.E.A. In the North of Scotland about half the total costs arise in the production of electricity, and distribution costs represent well over a quarter of the total. Main transmission on the other hand costs only about a quarter of distribution. The proportions of total costs are very similar in the case of the rest of Britain, with the exception of main transmission. Costs of production of electricity are higher than for the Board ; but if transmission costs are added to costs of production there is not much difference between them, the steep rise in the Board's transmission costs having nullified much of its production advantages. Distribution costs are lower in the rest of Britain, as one would expect, while rates are about the same. Management costs are now similar, having remained stable in the B.E.A. area but falling rapidly in the North of Scotland as output has expanded ; this fall reflects the spreading of overheads in a growing concern.

The net result of these various factors is that both costs and sales-price were higher in the Board's area than in the rest of Britain, and that the gap widened fairly consistently from 1949 to 1953. The excess of costs rose from ·07d. per unit sold in 1949 to ·15d. in 1953, and the excess of receipts rose from ·06d. to ·09d. per unit sold, the differences reflecting a difference in profits and reserve policy. 1954 was a peculiarly favourable year for the Board because of the heavy rainfall, and in that year for the first time the gap in costs was lower than in 1949.

[24] In 1954, a favourable year for hydro-electricity, the rise would be from ·1077d. to ·1428d.

TABLE VI

COSTS OF ELECTRICITY IN THE NORTH OF SCOTLAND AND THE REST OF BRITAIN

(Pence per unit sold)

Year	Generation and purchase	Trans-mission	Distribu-tion	Rates	Manage-ment	All costs	All receipts
	North of Scotland [1]						
1949	·5782	·0119	·3917	·0801	·1751	1·2369	1·2706
1950	·5642	·0585	·3571	·0622	·2054-5	1·2473-5	1·2379
1951	·6398	·0769	·3514	·0524	·1762	1·2967	1·2903
1952	·6805	·1001	·4068	·0536	·1500	1·3910	1·3856
1953	·7540	·1109	·4261	·0585	·1215	1·4710	1·4726
1954	·6902	·1077	·3948	·0562	·1167	1·3656	1·4117
Increase 1949-54	·1120	·0958	·0031	−·0239	−·0584	0·1287	0·1411
	British Electricity Authority [2]						
1949	·65	·03	·30	·07	·12	1·17	1·207
1950	·67-6	·02	·29	·06	·11-2	1·16	1·188
1951	·71-2	·02-3	·30-1	·06	·13-10	1·22	1·227
1952	·76	·03	·32	·06	·11	1·29	1·319
1953	·79	·03	·32	·06	·12	1·32	1·380
1954	·80	·03	·31	·06	·11	1·31	1·377
Increase 1949-54	·15	—	·01	−·01	−·01	0·14	0·170

[1] Between 1949 and 1950 there was a slight change in the method of accounting for management expenses and the surplus. Sales include units used in construction.

[2] Years from 31st March to 31st March. The figures for some items are not exactly comparable between 1949, 1950 and 1951 because of changes in accounting procedure. Where it makes a difference the figures are given on both methods, the first figure representing the method of the preceding year. The B.E.A. figures have been calculated on the same basis as those for the Board. The main difference from the figures as given in B.E.A. *Reports* lies in the addition of charges for depreciation, interest and rents, insurances, etc., to the particular charges for each item. Distribution in the case of B.E.A. includes distribution costs, meter-reading, etc., changes of systems (consumers' apparatus), and the whole of the Area Boards' depreciation, interest and rents, insurances, etc. Though it is unlikely that the two sets of figures are exactly comparable, the comparison is probably fair.

III

Production Policy

In relation to the choice between generation by steam, atomic energy or water power, there are three sets of questions that have to be asked. (1) Is it right to expand investment in hydro-electricity? In particular, what policy should be followed in relation to the eastern coastal belt?[25] (2) On the assumption that existing steam stations will not be rebuilt or replaced when they finally become unusable, in what circumstances is it economic to use them, in the meantime, rather than build hydro-electric schemes? (3) On the assumption that there is an excess of capacity to meet current needs, either seasonally or for a prolonged period, which stations should be used to produce electricity? All these questions are relevant to the day-to-day policy decisions of the Board. It is regrettable that in their *Reports* they do not give the relevant information on which a full examination could be based, nor do they justify the policy they actually follow in economic terms. Nevertheless it is possible to attempt some estimates from the figures available.

A fair comparison must take account of a number of factors not allowed for in the actual accounting costs shown in the *Reports* of the Board and the B.E.A. (*a*) Depreciation on capital must be taken at current replacement cost, whereas the published figures reflect only historical costs at lower price levels. (*b*) We must somehow allow for risk and uncertainty. The average period over which the capital cost of a steam generating station is amortised is usually taken as thirty years—forty years for the building and twenty-five years for the plant in the ratio of one to two.[26] In the case of hydro-electric schemes, the civil-engineering work and dams are amortised over eighty years, the other buildings and plant being treated as in the case of steam stations. Capital expenditure on hydro-electric schemes has been distributed between buildings and civil-engineering works on the one hand and plant and machinery on the other in the proportion of about nine to one.[27] We might take the normal period there-

[25] Where more than half the potential consumers must live. Cf. *Report*, 1954, p. 59.

[26] B.E.A., *Report*, 1949-50, Appendix 43, and Cmd. 8647, *National Policy for the Use of Fuel and Power Resources* (Ridley Report) (H.M.S.O., London, 1952), Appendix III, p. 89.

[27] £56 m. and £6·5 m.

fore as about seventy years.[28] With these periods we have to compare the ten to twenty years of working life allowed for a nuclear reactor.[29]

The provisional programme announced in February 1955 envisaged two nuclear power stations being in operation in 1960-61 apart from the experimental Calder Hall station, a further two in 1963, four more in 1963-64, and a further four in 1965.[30] It seems unlikely that in ten years' time, with the speed of atomic energy development, the situation will be anything like it is today. One has only to look back to the pessimistic views expressed ten years ago as to the practicability of atomic energy at reasonable cost. Not only will atomic energy costs probably be much lower than at present, but improved methods of using atomic fuel will be available.

This means that there is a very great risk of obsolescence involved in any investment in conventional power plant. Looking ahead for thirty years, it would not be unreasonable to build some more steam power stations, but it is impossible to look ahead for fifty or more years with any confidence. By then hydro-electric stations built at very great capital cost may be as obsolete as the horse and carriage. There are two theoretical ways of dealing with this problem : either to charge a very high rate of interest to hydro-electric schemes, or to reduce drastically the assumed life of the assets. The problem is not in fact one of the correct charges to be levied by the Board, but one of the basis of calculation when investment schemes are planned. In fact hydro-electric schemes will continue to be used as long as *total* atomic energy costs are higher than the very low running costs of hydro-electric schemes. The loss is incurred today, when in a time of capital shortage vast sums are devoted to what may prove to be white elephants in thirty years' time. Therefore in our calculations we propose drastically to reduce the amortisation period to thirty years, in comparing hydro-electric with other costs.

(*c*) Most of the available calculations take current coal costs, and assume that coal is fairly priced. But the real cost of coal to

[28] Taking the ratio of civil-engineering to building work as eight to one. Hutton and Roskill, *op. cit.*, used amortisation periods of twenty years for plant, and thirty years for buildings and dams, etc., for both steam and hydro-electric stations, and ratios of 1 : 3 and 4 : 1 respectively, giving much shorter overall average periods of twenty-two and a half years for steam stations and twenty-eight years for hydro-electric schemes. The latter figure is much too short if the period is to be based on the actual length of life of the assets. This is one reason why their conclusion as to the economic feasibility of hydro-electric schemes was too pessimistic. Another was the comparison of both schemes at 80 per cent. load-factor. Furthermore, since then coal prices have risen relatively to other prices.

[29] Cmd. 9389, *A Programme of Nuclear Power* (H.M.S.O., London, 1955), p. 3.

[30] *Ibid.*, p. 6.

consumers today is not the average price which the National Coal Board thinks fit to charge, but is to be seen more accurately in the actual costs of marginal pits which make large losses, or in the prices to be gained in export markets or paid for imports. The N.C.B. makes a profit of about £1 per ton on coal sold abroad, and a loss of £2 or over on imported coal; costs at marginal pits must be at least 15s. to £1 above average costs.[31] To take account of these facts, and the rising marginal costs of coal as less easily accessible coal seams are exploited, we propose to raise assumed coal prices by about £2 per ton, adding 50-70 per cent. to fuel costs per unit generated.[32]

We can now proceed to compare steam, atomic energy and hydro-electric costs. The most recent estimates suggest that the cost of generating electricity in modern steam stations, operating at a high load-factor, say 90 per cent., and with a thermal efficiency of 30 per cent., would be about ·60d. per unit; of this ·38d. represents fuel cost (including handling), and ·22d. covers other costs including interest and depreciation.[33] These other costs must include about ·07d. for 'other works costs' (cf. Table V), leaving ·15d. for capital costs. If the station were worked only at average load-factor, the other costs would rise to ·44d. per unit (·3d. for capital costs); capacity required for peak loads would cost even more.[34] Raising fuel costs by 50-75 per cent. would add ·19 - ·28d. per unit, making total costs ·8 - ·9d. for a base-load station and 1·0 - 1·1d. for a station worked at average load-factor.

If such a station were built in the north-east of Scotland, it would have to pay a higher price for coal than the average B.E.A. price assumed in these calculations, and would not be able to work at more than average load-factor. Coal costs in the Board's area are about 15 per cent. higher than elsewhere, so that we need to add a further ·06d. per unit, making total costs 1·1 - 1·2d. per unit.

[31] See 'The Price of Fuel', *Oxford Economic Papers*, September 1954, p. 229. A price to equate demand and supply might be as much as £3 per ton above average costs. Losses in the Alloa area of the Scottish Division were 16s. 3d. per ton in 1954, the Scottish Division as a whole making a loss of 4s. 7d. per ton. The largest area loss was 30s. 6d. per ton (Neath). Individual colliery results would show a much larger divergence, and it is costs at the marginal pits that matter. The 18 per cent. rise in prices in July 1955 (11s. 5d. per ton, 9s. 3d. to power stations) is clearly not enough to cover marginal costs, and is indeed due to rising average costs. Cf. *The Times*, 9th July 1955.

[32] To argue that coal is scarce, and therefore should be reckoned at a high price, is not equivalent to arguing that there is any virtue in saving coal for its own sake, as the Hydro-Electric Board frequently does. By using coal as a yardstick of value, as it did in its evidence to the Ridley Committee, it has avoided the severer test of relative costs.

[33] Cmd. 9389.

[34] 1·73d., including 1·18d. for capital costs, for a load-factor of about 11 per cent. (one thousand units per KW. per annum).

It is impossible to do more than guess the ultimate costs of atomic energy. Capital and works costs, including fuel costs, of the first two types of reactor can be reasonably calculated; but fuel costs are uncertain, depending, in particular, on estimates of the value of the plutonium produced as a by-product. This will be used as the raw material of the later, more efficient, reactors. The higher the value put on the by-product in the early stages, the lower the costs of the early stations, but the higher the cost of later stations. The official estimates of February 1955, which took no account of any military value of plutonium and valued it at many thousands of pounds a kilogram, at 'what appears to be a reasonable value', resulted in commercial costs of atomic energy from the first stations of about ·6d. per unit—costs similar to those of the most efficient steam stations.[35] Later examination of these figures has suggested that the costs may be as low as ·43d. per unit, and will rise to only ·76d. if no credit is given for the plutonium.[36] Capital costs may be about twice the net fuel costs, and running costs will be much lower than those at steam stations, so that these reactors will be used as base-load plants.[37] In other models the proportions could be the other way round, and capital costs may be relatively low in the third-stage reactors, which will not come into operation before the 1970s.[38] It is thus clear that within ten years, or perhaps less, it may be feasible to construct atomic energy stations at economic costs for general use at fairly low load-factors, though there are technical difficulties in 'turning on and off' some types of nuclear reactors.

The main cost of hydro-electricity lies in the capital charges; other costs run at about ·04d. per unit generated. Capital costs now lie somewhere between £70 and £120 per thousand units per annum. The incidence of these depends on the period over which they are amortised. In Table VII a comparison is made with the costs of steam stations operating at various load-factors; the effect of spreading

[35] Cmd. 9389, Part II, particularly para. 19. This assumes a load-factor of about 80 per cent.

[36] Mr. J. A. Jukes of the U.K. Atomic Energy Authority. With plutonium sold net (after allowing for costs of separation) at £5-10 per gram, costs would vary from ·59d. to ·43d. He regarded the last figure as the more reasonable, and estimated prices of £12 per gram during the greater part of the life of reactors built in the next few years. The price at which the U.S. will sell enriched uranium, which is in many ways equivalent to plutonium, is £8 18s. per gram of U-235. An American estimate of the cost of later types of reactor, allowing for enriched material worth £5 - 11 per gram, was ·35 - ·43d. for various kinds of second- and third-stage reactors. Cf. *The Times*, 9-10th August 1955.

[37] Cmd. 9389, and Sir Christopher Hinton at the Geneva Conference, *The Times*, 16th August 1955.

[38] Cmd. 9389, pp. 2, 18. The fast reactor at Dounreay in Caithness is an experimental model for a station of this type.

capital charges over various periods is also shown. It is clear that the apparently favourable results of hydro-electric generation depend entirely on the relatively low capital charges inherited from past schemes, and on the long period of amortisation of capital.

TABLE VII

COSTS OF STEAM AND HYDRO-ELECTRIC STATIONS [1]

(Pence per unit generated)

Steam costs	Load factors		
	90%	45%	15%
Fuel costs	·38	·38	·38
Other costs	·22	·44	1·32
Total costs	·60	·82	1·70
Plus 50-75% added to fuel costs	·79 - ·88	1·01 - 1·10	1·89 - 1·98
Plus 15% for extra North of Scotland fuel costs	·85 - ·94	1·07 - 1·16	1·95 - 2·04
Hydro-electric costs	**Amortisation period**		
	30 years	50 years	70 years
Works cost	·04	·04	·04
Capital charges:			
(*a*) Capital cost at £70 per 1,000 KW. H. per annum	·97	·78	·72
(*b*) Capital cost at £100 per 1,000 KW. H. per annum	1·39	1·12	1·03
(*c*) Capital cost at £120 per 1,000 KW. H. per annum	1·67	1·34	1·23
Total costs (*a*)	1·01	0·82	0·76
(*b*)	1·43	1·16	1·07
(*c*)	1·71	1·38	1·27

[1] Capital is charged 4 per cent. interest, and the annual payments are calculated on the actuarial method used in the Ridley Report (Cmd. 8647, Appendix III, p. 85).

If due allowance is made for real coal costs, which works in favour of hydro-electric schemes, it can be seen that hydro-electric schemes amortised on a conventional basis can operate economically in the North of Scotland in place of steam stations working at an ordinary load-factor only if their capital cost can be kept below £110 per thousand units of average annual output. But it is quite unreasonable,

as we have argued, to amortise them over periods as long as this. Amortised over thirty years, they can compete only at capital costs of £80 per thousand units per annum. But this comparison involves a unit cost of 1·1 - 1·2d. for an ordinary 45 per cent. load-factor station. At 1d. per unit, atomic energy may well soon be able to compete even for low load-factors.[39]

When we turn to peak-load operation, the margin of advantage passes to hydro-electricity even for fairly high capital costs. But when capital costs rise above £130 per thousand units, amortised over thirty years, the cost is equal to diesel costs at 1·85d. per unit.[40]. For peak-load operation pumped storage schemes also come into consideration.[41]

We can now answer the questions we raised. (1) The marginal cost of power from hydro-electric schemes is so low compared with the marginal fuel costs of steam stations that it is economic to use Aberdeen and Dundee as standby stations. (2) How far is it economic to continue to use old steam stations rather than build new hydro-electric stations? We have now to compare *total* costs in hydro-electric plants with *current avoidable* costs in steam stations. Works costs at Aberdeen are ·8 - 9d. per unit, and ·6 - 7d. at Dundee, or, if we raise coal prices by our assumed amount, 1·0 - 1·2d. and ·8 - 1·0d. respectively. At these costs, the total costs of new hydro-electric schemes begin to be comparable, and may be somewhat lower than Aberdeen current costs. But we have to add something for the extra transmission from hydro-electric stations, perhaps of the order of ·11 - ·16d., though some of this should perhaps be counted as the cost of reserve capacity in the system ; connection with hydro-electric stations will exist in any case. Nevertheless, the works costs at Aberdeen in particular are extremely high ; only 5 per cent. of the output in the rest of the country comes from stations with such high fuel costs.[42] Replacement will soon be inevitable, and the figures suggest that the total costs of a new steam station would be no higher than present works costs.

(3) How far is it right to go on building new hydro-electric schemes? The average output of schemes in operation in 1954 was 1,123 m. units ; schemes under construction will produce another 1,168 m. units, and another 1,340 m. units will come from schemes

[39] But detailed estimates of costs are not available.
[40] See Table III.
[41] See J. Eccles, ' The Generation of Electricity—British Electricity Authority ', *British Electrical Power Convention*, June 1955, pp. 22-3, on the Ffestiniog scheme.
[42] B.E.A., *Report*, 1954-55, p. 212.

promoted or in course of promotion and survey.[43] It seems unlikely that these latter schemes will be producing electricity before the 1960s, when the costs of atomic energy will be much more capable of realistic assessment. It is thus clear that no further hydro-electric schemes should be built for normal operation ; and it may well be doubtful whether some of the promoted schemes should be started. The only exception might be for small schemes designed to meet local needs in remote Highland areas, where coal costs are much higher than at Aberdeen, provided that it can be shown that hydro-electric stations amortised over a short period can compare favourably with diesel costs.

A different question arises in the case of peak-period electricity. Here there is a clear case for building hydro-electric stations, but the supplies are needed in the south of Scotland and England, and output from stations in many parts of the Highlands will involve very high transmission costs.

The problem of serving the eastern coastal belt remains. The existing stations are expensive, particularly the one at Aberdeen ; and hydro-electric supplies are equally expensive. Supply from an efficient power station on the Fife coalfields would involve very high transmission costs and difficulties of practical operation. To build a new steam station at Aberdeen would be reasonable, but, in view of the relatively high coal cost, it would be better to consider building an atomic energy station.

IV

Prices

If it was ever thought that hydro-electricity generated in the North of Scotland would be cheap, it has not proved so. The overall figures are given in Table VIII, and compared with the position in the B.E.A. area. It will be seen that consumers in the North of Scotland pay about 10 per cent. more for their current than consumers in the rest of Britain. But they pay, on average, less than consumers in the London, Southern, South Western, and South Eastern Areas of Britain.[44] We also need to compare the charges for the four main categories of consumers—domestic, farms, commercial and industrial—and the figures from 1950 to 1954 are given in Table IX. It will be seen that for every category and for every year, except for sales to farms and commercial premises in 1952 and 1954, the average prices

[43] *Report*, 1954, p. 8.

[44] With the exception of the South Eastern Area in 1953-54. See Table A5 of the B.E.A. *Reports*.

TABLE VIII

THE PRICE OF ELECTRICITY, 1949 - 54

(Pence per unit sold)

Year	North of Scotland Hydro-Electric Board			B.E.A.[1]
	Units used in area	Units sold to B.E.A.	All sales	All sales
1949	1·345	·556	1·271	1·207
1950	1·358	·703	1·238	1·181
1951	1·411	·941	1·290	1·220
1952	1·498	1·109	1·386	1·311
1953	1·583	1·165	1·473	1·373
1954	1·563	1·046	1·412	1·370
1954 as % of 1949	116	188	111	114

[1] B.E.A. figures are for years ending 31st March, except for 1949, and exclude small sales to the North of Scotland Hydro-Electric Board.

TABLE IX

PRICES OF ELECTRICITY BY CATEGORIES OF CONSUMERS, 1950 - 54 [1]

(Pence per unit sold)

Year	Domestic		Farms		Commercial		Industrial[2]	
	Board	B.E.A.	Board	B.E.A.	Board	B.E.A.	Board	B.E.A.
1950	1·4145	1·327	1·343	1·322	1·790	1·726	1·181	·948
1951	1·422	1·353	1·357	1·339	1·764	1·760	1·209	1·002
1952	1·485	1·452	1·327	1·397	1·813	1·831	1·361	1·088
1953	1·597	1·532	1·484	1·463	1·924	1·911	1·412	1·143
1954	1·564	1·518	1·463	1·472	1·820	1·901	1·410	1·149
1954 as % of 1950	111	114	109	111	102	110	119	121

[1] See Notes to Table II. The B.E.A. figures for all years are, however, comparable in this Table.

[2] Industrial sales exclude units used in construction in 1950 and 1954, and include them in other years. In 1954 these units were sold at 1·4978d. per unit, *i.e.* at a higher price than sales to other industries, so that our figures for 1951 - 53 may be higher than they would be on a comparable basis. The equivalent combined figure for 1954 is 1·421d., so that it can be seen that this will not affect the comparison in general.

paid in the Board's area were above those of the B.E.A. For farms and commercial premises the prices were not very much higher than those of the B.E.A., and for the domestic consumer the difference was less than 10 per cent.; but the industrial consumer paid over 20 per cent. more than in the rest of Britain though less than the industrial consumer in London.[45] It is necessary to remember that these are average prices, and that the lack of large-scale industry in the North of Scotland raises the average price.

Apart from areas supplied by diesel generating plants, there is a uniform tariff throughout the North of Scotland area. How far is this justified? A uniform charge will restrict the expansion of sales of electricity in the 'cheap' areas—in the areas where it *costs* less to produce and sell electricity—and will subsidise the expansion of sales in 'dear' areas. There is nothing to be said for restricting the sales of a cheap commodity, at least in the case of electricity. On the other hand, there *is* a case for subsidising sales of electricity in 'dear' areas. The general case against subsidies for commodities of normal every-day consumption, that consumers would be better off if they were given an equivalent sum of money and allowed to spend it as they wanted, *might* not apply in the case of electricity, if it can be shown that it is desirable on some general social grounds to encourage its widespread use. This argument is particularly powerful where the cost in question is to a large extent a capital cost, *e.g.* that of laying mains to outlying farms and villages, and where the cost of supplying current, once the mains have been laid, is not high. But, conceding this case, there is still no case for extracting the subsidy for these consumers from a particular group of other consumers of electricity in 'cheap' areas, especially when this tax on their consumption is not only arbitrary but also discourages them from making full use of a cheap commodity. It would be better for everybody if some sort of general levy were exacted from them, rather than that they should pay more for their electricity. It seems probable, if not certain, that distribution costs in the coastal belt are lower than the average throughout the Board's area.[46] The Board's distribution costs, as seen in Table VI, are higher than those of the B.E.A., whereas distribution costs in the eastern coastal belt cannot be very different from those throughout the country. It seems likely therefore that Aberdeen and Dundee consumers are paying for high-cost distribution in the rest of

[45] Industrial consumers in the Southern Area also paid more in 1950-51, 1951-52 and 1954-55, and perhaps in 1952-53, and in the South Western Area in 1951-52.

[46] Underground mains are dearer than overhead lines, but density of consumers per main is much greater in urban areas.

the area, as indeed the urban consumer does generally. But the burden here may well be greater than in most other areas of Britain, because of the low degree of industrialisation and the high proportion of rural sales, though no accurate estimates of the ratio of urban to rural sales can be made. Aberdeen and Dundee should pay no more for their current than it would cost to provide it in the cheapest possible way, irrespective of how it actually is provided.

How far are the customers whom it is very costly to serve made to pay for the costs they incur? We have noted the rising cost of distribution to new customers ; and the policy of bringing electricity to distant farms and crofts is obviously extremely expensive. Even the Board rather regretfully remarks : ' Indeed, owing to the distance and expense, there are a few whom it may not be possible to reach in our lifetime.'[47] In the same *Report* it was anticipated that the number of new consumers connected to the mains would diminish from year to year, though expenditure would remain at about the same level.[48]

An appropriate tariff for such customers would be one that required them to pay for those capital costs of connection which are in excess of the normal cost of connecting an ordinary consumer. This capital cost could be charged either in the form of a lump sum or alternatively in the form of an annual guarantee of a minimum demand, as is sometimes done and as is universally the case on a more limited scale with the block tariff.[49] It is clear, however, that, though the practice of an annual guarantee is sometimes used, in general the higher cost of distribution is spread over all customers, thus inhibiting the use of electricity in the cheaper areas.

How far does the tariff reflect the particular structure of hydro-electric costs ? Compared with steam generating costs, hydro-electric costs are largely capital costs with small running costs. Thus the cost of supplying a customer with additional current, once he has paid for the capital costs of supply and the connection costs involved in supplying him personally, is very small, but in fact the tariff, though it has three blocks (four in winter), never falls below ·9d. per unit in summer (·6d. in winter) for supplies to domestic, farm and commercial customers. The running costs of industrial supplies are ·66d. per unit for high-voltage supplies, ·72d. for low-voltage supplies, and may be more for a ' mixed load '.

It may well be asked whether these tariffs adequately reflect the low marginal costs of supplying current in the North of Scotland.

[47] *Report*, 1953, p. 9.
[48] *Ibid.*, p. 18.
[49] *Report*, 1951, pp. 16-7.

Admittedly, a tariff involving a larger capital commitment at the outset might dissuade some customers from using electricity at all, and might put a heavy burden on low income-groups. The first difficulty is hardly likely to be important, except in the cases of outlying farms mentioned earlier, where the economic case for providing electricity is in any case somewhat doubtful. The second difficulty should be dealt with by other means, such as increased allowances to pensioners or even special rebates of the capital contribution (first block) for particular low income-groups, rather than by the adoption of a method of pricing that generally discourages the use of cheap resources. On the other hand, though marginal supplies of current cost little to produce, there are for the present only limited quantities available, dependent on water supplies. A too indiscriminate lowering of marginal supply-prices might lead to shortages of current.

An important part of the revenue of the Board comes from bulk sales of current to the electricity authorities outside the Board's area. This represents about one-fifth of the total revenue received from sales of current. The price at which it is sold, as shown in Table VIII, is below that at which current is sold in the area, being about two-thirds of the cost to local purchasers. On the other hand, the price is high for bulk purchases of current, as can be seen by comparison with the price of B.E.A. electricity to its final consumers and by the fact that since 1950 it has been much above the average generation and main-transmission costs of the Board.[50] The current is supplied under a long-term contract, by which the price is the grid tariff for the year, charged to Area Electricity Boards by B.E.A., less 4 per cent.[51] In this way some help is given to the North of Scotland by the rest of the country. Whether it is enough is another question.

V

Social Costs

Hitherto we have rigorously ignored social considerations. This is not because they are unimportant, but because the cost of social benefits must be seen clearly before we decide to grant them, even if our final decision is not based on questions of cost. How is the economic balance-sheet altered when we take account of social benefits?

1. The North of Scotland is an area ill-favoured by nature, and its standards of living are low. In order to maintain modern standards,

[50] Cf. Table VI.
[51] *Report*, 1951, p. 15.

the Government provides it with subsidies of various sorts, and special expenditure of many kinds has been common in recent years. What the area needs is investment that will enable it to earn a reasonable living in the modern world. One form of investment that has for long been envisaged for the Highlands is precisely that which the Board has been carrying out. We have seen reason to doubt whether the economic return on hydro-electricity is as great as is sometimes assumed and whether continued investment in it is justified rather than in other methods of producing electricity. The social argument might be used here to suggest that investment that will not earn its keep elsewhere is justified in a ' development area ' as an alternative to subsidies of a more temporary character. But this argument can be used only if it can be shown that this form of investment will help the Highlands more, *i.e.* give a greater return for a given investment expenditure, than an equivalent programme in another direction, *e.g.* in the form of water supplies, roads, piers, forestry, improvement of tourist facilities, agricultural investment, etc. Detailed examination of this issue is impossible, but common sense suggests that electricity from some source or other can justly be placed fairly high on the list of priorities up to the point of saturation of the Highlands.[52]

2. How far is there a case for subsidising electricity in the North of Scotland? Throughout the country the urban consumer subsidises the rural consumer of electricity. In the case of the North of Scotland, as we have seen, the urban customer may have an even heavier burden to bear. Neither Aberdeen nor Dundee is an area of such flourishing industry with such an assured future that it can afford to discourage industry by failing to have cheap supplies of power. There is a case for charging some of the extra cost of supplies in the North of Scotland, if it is thought fit to continue with the expansion programme, to the general consumer throughout Britain or to the tax-payer.

But this is to assume that the out-of-the-way farm or croft is entitled to a supply of electricity at well below cost. What justification is there for this? It has now become accepted policy, and rightly so, that the way of life in the Highlands should be preserved and further depopulation discouraged. The Crofting Commission indicated the important place that electricity occupies among the conveniences of life which the crofter demands, and without which depopulation will tend to continue.[53] This seems an entirely adequate reason in modern conditions for some special assistance for the electrification of these

[52] But compare the Crofting Commission's emphasis on the need for better water supplies. Cmd. 9091, *Report of the Commission of Enquiry into Crofting Conditions* (H.M.S.O., Edinburgh, 1954), para. 49.

[53] Cmd. 9091, paras. 49-51, 102.

areas. It must however be remembered that, as the Board has claimed on several occasions, consumers in remote districts, after connection to the main, are often not only getting better heating and lighting but paying less for them than before.[54] This does not argue well for charges below cost.

3. Finally there is the question of the destruction by the Board of the beauty of certain parts of the Highlands.[55] Even if we discount some of the complaints as mere conservatism, there remains a heavy charge to bear. It is regrettable that the engineers of the electricity industry, who have brought so many amenities of life to mankind, have often succeeded in destroying parts of the very limited areas of really beautiful scenery in Britain. Sometimes they have persuaded cost-conscious economists that the saving of replaceable resources is more important than the destruction of the irreplaceable beauties of nature. The Hydro-Electric Board is obviously not in a strong position to deny the importance of such social costs. Moreover, the outside inhabitant of more favoured areas is unlikely to be impressed by demands for help in order to support the ' way of life ' of the Highlands if its inhabitants are either so careless of its beauties or so insensitive to them that they are ready to see them destroyed for the sake of supposedly cheap electricity. If, in the last resort, it is decided that we must destroy some of the beauties of the Highlands, we should at least be sensitive to what is being lost.

D. L. Munby

Aberdeen

[54] *Report,* 1953, p. 21 ; *Report,* 1951, p. 53 ; Cmd. 9091, para. 51.

[55] The Clunie scheme, opened in 1950, left scars on the hillside on the far side of Loch Faskally that mar the view from above Pitlochry. The Loch Sloy scheme has created great gashes with its pipes down the side of Loch Lomond. Perhaps trees will cover the damage in time. It is not argued that all the Board's schemes have damaged amenities, nor is it argued that the power stations and dams are in themselves ugly ; but a masterpiece by Le Corbusier would not compensate for the destruction of Adam's Register House.

THE CONSTRUCTION COSTS AND THE VALUE OF THE BRITISH MERCHANT FLEET, 1850 - 1938[1]

I

Introduction

The student of shipping has a great advantage over his colleagues in other fields, for the statistical evidence on the physical volume of the main group of assets, vessels, is quite exceptional. The series of registered tonnage goes very far back, and is unique in giving a breakdown by years of origin after 1910. This opens rare opportunities for relating the structure of assets to past economic development, technological conditions, the historical costs of construction, and other influences. There remain, however, considerable obstacles to investigation of these relationships ; in particular, there are the difficulties of calculating the construction cost of the fleet in the second half of the nineteenth century. Information on construction costs is very fragmentary or indirect before 1900, and, since the development of this information into a continuous series has required the use of assumptions as yet unverified, this paper must be regarded as tentative.[2]

In this paper all measures are given as rates per registered ton. The economic significance of this unit has undergone a number of major changes which may fairly be called revolutionary, but it has the obvious advantage of maintaining a convention deeply rooted in all available sources. Acceptance of this conventional unit of measurement does not imply that changes in its economic significance can be ignored in interpreting the results.

It is expedient to keep to this measure because of the absence of any other that would be fully as satisfactory for long-term analysis. Technical development has so often changed the economic significance of the various units used to measure shipping capacity that even an attempt to come nearer to an economically-defined unit, by the introduction of the deadweight ton, is subject to qualifications. *Fairplay's Journal* gives repeated warnings, including this opinion by a shipbuilding expert : ' To value ships at so much per deadweight

[1] I wish to thank Mr. J. J. McGibbon for his patient help in collecting the information for this paper, and Mr. A. A. Adams for his improvement of the English in the original manuscript.

[2] Publication of this paper is intended to be only one stage in a programme of research which cannot be completed satisfactorily without the co-operation of those in whose archives lies the material that would illuminate or settle many of the problems described above. In particular, information about actual sales and purchases of ships in any of the years of the investigation would be of great help.

ton is a positive absurdity that has crept into the business of buying and selling ships. . . . The continued use of this expression can only lead the ship-designer . . . to design vessels that will cost the lowest

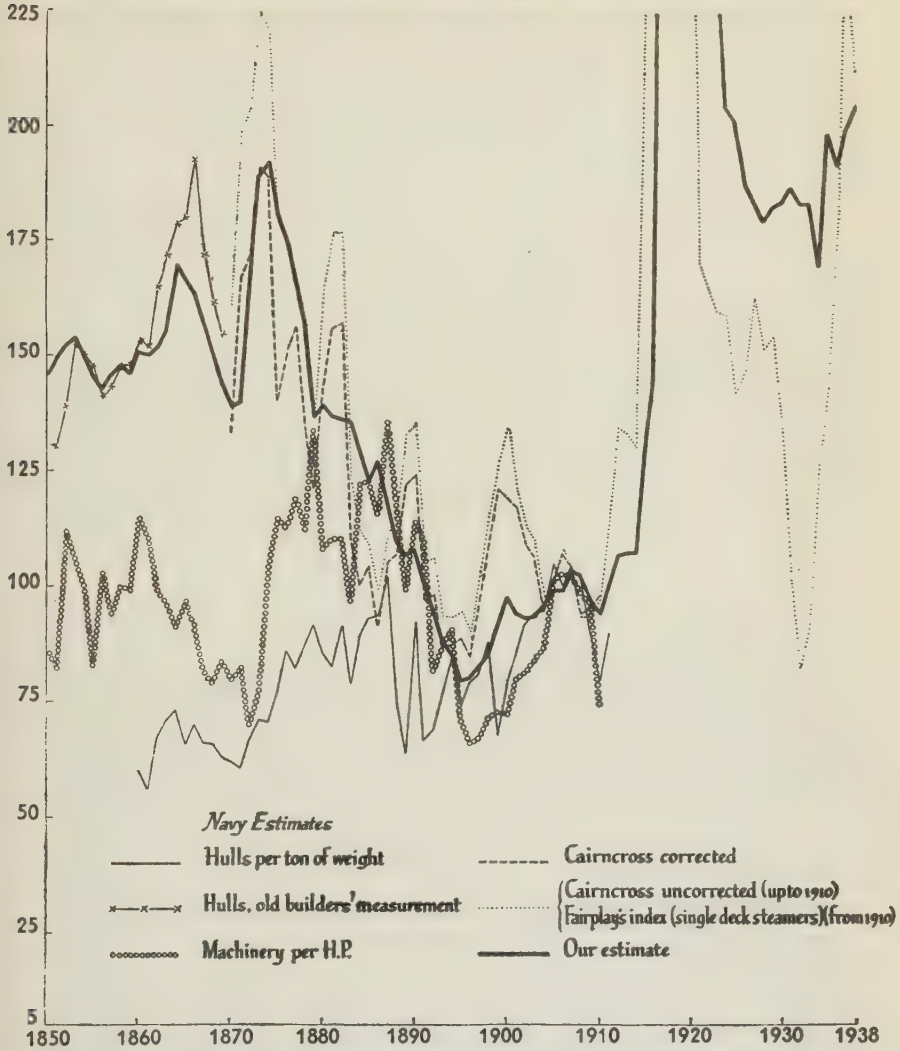

FIG. 1. Information on the construction costs of steamers, 1850-1938. (1905-09 = 100)

amount per ton . . . disregarding efficiency and economy in service.' The absence of an economically satisfactory unit of shipping space gives rise to ambiguity in all measurements of construction costs, for price must be vague if quantity is ill-defined. The difficulty affects all

the problems treated: in examining the influence of the buying-pattern of assets, for example, there remains a margin of ambiguity though we can achieve a reasonable approximation.

A survey of the sources suggests that it will be convenient to divide the period into two, before and after 1910, and also to treat separately the cost of hulls and the cost of machinery. On the other hand, separate estimates have not been made for sailing vessels; instead it has been assumed that the cost of hulls per gross ton for steamers corresponds to the cost of hulls per net ton for sailing vessels.

It seemed convenient for technical reasons to divide the whole period and to include the first decade of the century in the first part. The cost series of exported new ships starts in 1902; and 1910 was the first year with direct information on the age-structure of registered tonnage, estimates of total value for earlier years being less accurate because of the need to use an imputed age-structure. The estimate of construction costs before 1910 necessitated the introduction of a number of assumptions and the use of auxiliary information from various sources. An account of these special problems follows, giving the technical details and showing the weak points where improvements are desirable.

II

Construction Costs up to 1910

Cost of Hulls

The development of the cost of hulls falls again into three periods distinguished by the materials used. These changes in materials had important effects on carrying capacity per ton, and were thus of considerable economic significance. The earliest period, in which *wood or composite* construction prevails, ends about 1862. In that year *iron* construction reached equality with its predecessor and predominated after that until 1886. Finally *steel* came to supplant the other materials within a time even shorter than that needed by iron for its victory over wood. In these circumstances information about the materials used in construction becomes of primary importance. Fortunately information is available on the average carrying capacity attained with each of the three materials; thus inferences can be drawn about the technological influences on construction costs for which otherwise only prices of materials and wage rates would have been available.

The estimates of costs from 1850 to 1862, before iron became the predominant material, rest on information from the *Navy Estimates*. The costs of hulls of naval vessels, other than those armour-plated, have been related to their tonnages in ' old builders' measure ',

and an index of these costs per ton has been used to take the series back before 1863, the years 1860-69 being used for linking. (During the period of overlap, 1860-69, the estimated cost of hulls per gross ton for merchant steamers was about 60 per cent. of the cost per 'old builders' ton' of naval vessels not armour-plated.[3])

Costs *before* 1850 have been added to the survey in only a summary form. Ships still in service in the sixties and seventies, though built before 1850, are described in the *Navy Estimates,* but they are few and the information is condensed by using averages over several years. These averages are not, however, out of proportion to contemporary construction periods.[4]

The revolutionary improvements in the production of iron and steel influenced construction costs much more than would be shown by indicators based only on prices of materials and wage rates. To make allowance for this it was necessary to measure the changes in materials necessary for constructing a unit of registered tonnage. The nearest approximation to this is a series of the changes in the average deadweight of all new vessels registered in each year. We cannot take into account all the constructional changes made possible by improvements in design, *e.g.* the size of ships, the purposes for which they could be used. The simple assumption is made that vessels built from each of the three materials have a typical carrying capacity; thus technological change is allowed for if the new tonnage of a year is evaluated by attributing to it the carrying capacity taken as typical for the material used. To obtain the typical carrying capacity, the coefficient reached by each of the materials at the peak of its development has been chosen: wood or composite tonnage has been assigned a carrying capacity of 1·8 deadweight tons per net registered ton, iron has a coefficient of 2·2, and steel one of 2·7.

The choice of these coefficients of carrying capacity for vessels built from various materials rests on information collected by the Commission on the Measurement of Tonnage[5] and information in shipping periodicals commenting on launchings of new vessels. For example, in the first source, Colonel E. S. Hill submitted 'a list of steamers having a deadweight capacity of rather more than twice the present net register'. This list contains twenty-five steamers owned by one company and built during the years 1875 to 1880. Their dead-

[3] In the fifties a shipbuilding expert estimated that the lighter scantling for merchant vessels required about one-quarter less timbering than for naval vessels. John Grantham, *Iron Ship-building* (London, 1858), p. 116.

[4] The *Hindustan* was begun in August 1828 and launched in August 1841.

[5] C. 3074—I. *The Measurement of Tonnage* (H.M.S.O., London, 1891). Minutes of Evidence.

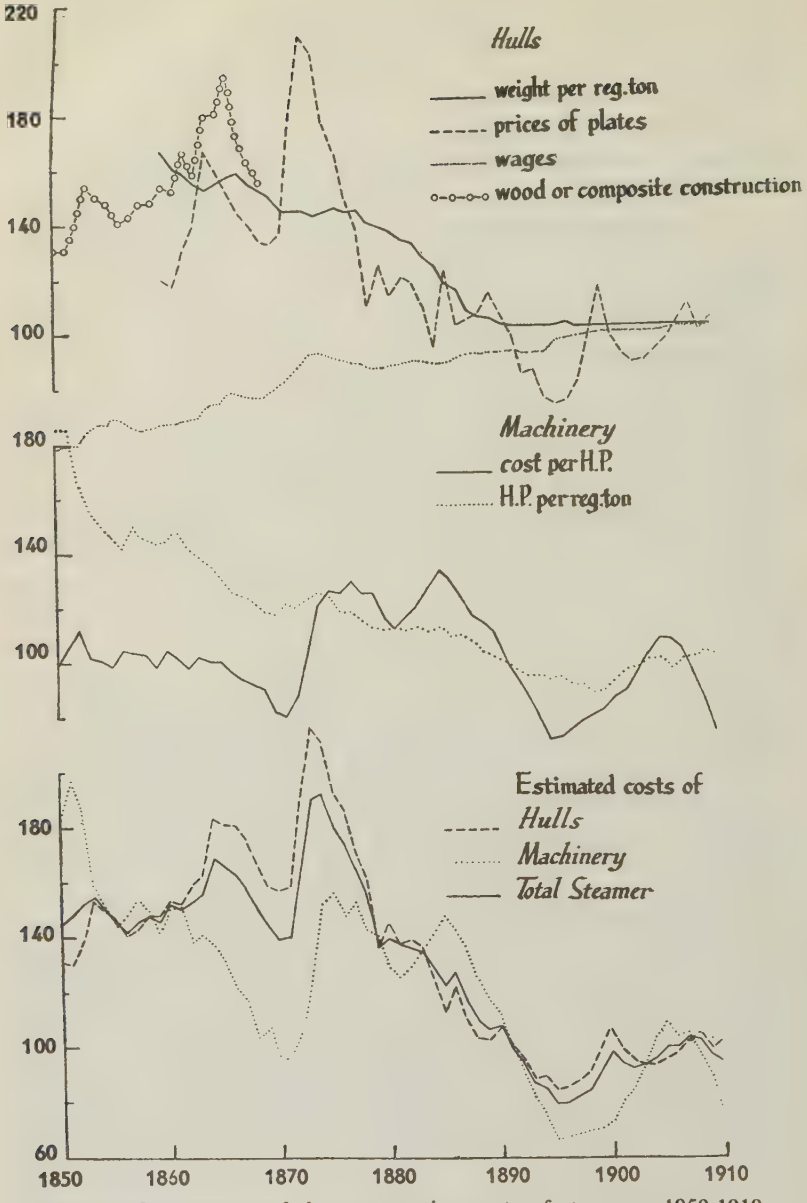

FIG. 2. Components of the construction costs of steamers, 1850-1910. (1905-09 = 100)

weight ranges between 2·0 and 2·3.[6] In another paper, submitted by Mr. M. Cay,[7] ships built between 1871 and 1880 have a deadweight ranging between 2·0 and 2·22 per net registered ton. Similar evidence is found in many other surveys. Quotations for ships built in the sixties are less frequent and give a deadweight fluctuating within ± 10 per cent. of 2·0. In later years information on the deadweight of new ships published in *Marine Engineering News* (later *Marine Engineering*) and in *The Shipping World* has been examined. All the information collected pointed to a rather earlier rise in the average carrying capacity of new vessels than is assumed in the conservative estimate of Sir Normand Hill (quoted by Crammond).[8]

We find that, as early as 1870, average carrying capacity, calculated from new tonnage weighted with regard to its material, has a deadweight of 2·0, and moves upward particularly rapidly in the middle eighties. The greatest change comes, of course, with the sudden substitution of steel for other materials in 1887. In this year more than two-thirds of new tonnage was made from steel (231,000 net tons out of a total of 307,000), and the computed average deadweight jumped to 2·54.

The calculated changes in the average carrying capacity of new tonnage cannot be related to changes in the construction costs of hulls caused by changes in their weight, before allowance is made for changes in the weight of machinery. These changes were described in a paper read before the Iron and Steel Institute,[9] according to which a set of machinery of 6,000 I.H.P. (indicated horsepower) had in 1890 a weight of 560 tons against the 1,000 tons of an equivalent set in 1875. Hence it is assumed that engines in our base period employed only one-half the carrying capacity needed for an equivalent propelling unit in the pre-steel era. The bulk of this saving can be assigned to the second half of the eighties ; thus the higher weight of machinery has been allowed for with a constant coefficient for one I.H.P. throughout the pre-steel era, though this is applied to changing I.H.P. per registered ton (cf. p. 52).

After this allowance for machinery, the remaining changes in average carrying capacity have been accepted as the best available approximation to the influence of the falling weight of materials on the construction costs of hulls. There remained the task of relating these changes to the costs of hulls in the base period. In the light of the

[6] *Op. cit.*, p. 179 and Appendix XIII, p. 766.
[7] *Op. cit.*, p. 197 and Appendix XV, p. 766.
[8] E. Crammond, *The British Shipping Industry* (London, 1917), pp. 12-3.
[9] A. E. Seaton, ' The Development of the Marine Engine, and the Progress made in Marine Engineering during the past Fifteen Years ', *Journal of the Iron and Steel Institute*, 1890, p. 477.

TABLE I

ESTIMATED AVERAGE COSTS OF STEAMERS, 1830 - 1938

(£ per gross registered ton. Indices, 1905 - 09 = 100)

Year	Total		Hulls only			Year	Total		Hulls only			Year	Total		Hulls only		
	Index	£	Index	£	% of total		Index	£	Index	£	% of total		Index	£	Index	£	% of total
1830-40	147	25·2	139	17·0	67·5	1878	156	26·8	162	19·7	73·5	1909	97	16·6	100	12·2	73·5
1841-45	133	22·9	122	14·9	65·1	1879	137	23·5	136	16·6	70·6	1910	94	16·1	102	12·4	77·0
1846-49	148	25·4	137	16·7	65·7	1880	140	24·0	145	17·7	73·8	1911	84	14·2	80	9·7	68·3
1850	145	25·0	131	16·0	64·0	1881	137	23·6	138	16·8	71·2	1912	107	18·0	107	13·1	72·8
1851	149	25·6	130	15·9	62·1	1882	136	23·4	139	17·0	72·6	1913	108	18·2	107	13·0	71·4
1852	152	26·2	139	17·0	64·9	1883	136	23·3	137	16·7	71·7	1914	108	18·3	108	13·2	72·1
1853	154	26·5	153	18·7	70·6	1884	129	22·2	125	15·3	68·9	1915	130	21·9	128	15·6	71·2
1854	150	25·8	150	18·3	70·9	1885	123	21·1	113	13·8	65·4	1916	144	27·3	171	20·8	76·2
1855	146	25·1	148	18·0	71·7	1886	127	21·9	123	14·9	68·0	1917	247	41·7	229	27·9	66·9
1856	142	24·5	141	17·2	70·2	1887	118	20·2	110	13·5	66·8	1918	251	42·4	268	32·7	77·1
1857	146	25·1	143	17·5	69·7	1888	110	18·8	104	12·6	67·0	1919	260	43·9	277	33·8	77·0
1858	148	25·4	148	18·1	71·3	1889	107	18·3	103	12·5	68·3	1920	332	56·1	339	41·3	73·6
1859	146	25·1	148	18·1	72·1	1890	108	18·5	107	13·0	70·3	1921	313	53·9	312	38·1	72·0
1860	152	26·1	153	18·7	71·6	1891	100	17·2	101	12·3	71·5	1922	496	83·8	528	64·4	76·8
1861	151	26·0	152	18·5	71·2	1892	95	16·3	96	11·8	72·4	1923	331	55·9	311	37·9	67·8
1862	153	26·3	159	19·4	73·8	1893	87	15·0	89	10·9	72·7	1924	205	34·6	189	23·0	66·5
1863	156	26·8	163	19·9	74·3	1894	85	14·6	89	10·9	74·7	1925	201	34·0	173	21·1	62·1
1864	170	29·2	184	22·4	76·7	1895	79	13·6	84	10·3	75·7	1926	188	31·7	159	19·4	61·2
1865	166	28·6	181	22·1	77·3	1896	80	13·7	85	10·4	75·9	1927	151	25·5	143	17·5	68·6
1866	163	28·1	181	22·1	78·6	1897	82	14·1	88	10·7	75·9	1928	179	30·3	160	19·5	64·4
1867	158	27·1	175	21·4	79·0	1898	85	14·5	91	11·1	76·6	1929	182	30·8	163	19·9	64·6
1868	150	25·8	167	20·3	78·7	1899	91	15·6	99	12·1	77·6	1930	183	31·0	155	18·9	61·0
1869	144	24·7	159	19·4	78·5	1900	97	16·7	108	13·1	78·4	1931	186	31·5	167	20·4	64·8
1870	139	23·9	157	19·2	80·3	1901	94	16·1	99	12·1	75·2	1932	183	31·0	155	18·9	61·0
1871	140	24·1	158	19·3	80·1	1902	93	15·9	96	11·7	73·6	1933	183	31·0	155	18·9	61·0
1872	167	28·8	193	23·5	81·6	1903	93	16·0	93	11·4	71·3	1934	169	28·6	145	17·7	61·9
1873	190	32·7	217	26·4	80·7	1904	96	16·4	94	11·4	69·5	1935	199	33·6	172	21·0	62·5
1874	192	33·1	211	25·7	77·6	1905	99	17·0	96	11·7	68·8	1936	182	30·7	160	19·5	63·5
1875	181	31·1	192	23·4	75·2	1906	99	17·0	98	11·9	70·0	1937	199	33·7	168	20·5	60·8
1876	174	30·0	186	22·7	75·7	1907	103	17·5	102	12·5	71·4	1938	204	34·4	179	21·8	63·4
1877	165	28·4	171	20·9	73·6	1908	102	16·6	105	12·8	77·1						

information collected up to the present, a fair estimate of such a basic weight seemed to be about 0·9 tons per net registered ton. The implications of choosing any other basis are apparent from Fig. 3. A more definite conclusion about the soundness of this choice will be possible after the collection of information on actual transactions has been extended.

In the meantime, there is only some sporadic and fragmentary information on the weight of ships. It comes from the eighties, when the revolutionary changes were being given most attention, though at that time the process was not complete. For instance, according to testimony given before the Royal Commission on the Depression of Trade, a steamer constructed in 1884 with a carrying capacity of 2,600 tons had a weight of 1,038 tons.[10] By our earlier coefficient, the carrying capacity of 2,600 deadweight tons implies a tonnage of about 1,000 net registered tons. (The assumed coefficient for steel construction, 2·7, would indicate 960 net registered tons, but the saving in the weight of machinery was not yet fully effective in 1884.) The chosen basic weight for hulls of 0·9 tons per net registered ton leaves, in this case, only 138 tons for machinery. In another calculation, published three years before, we find the weight of machinery put at 0·158 tons per net registered ton (for a steamer of 1,667 net registered tons).[11] Such sporadic information[12] gives, of course, nothing more than illustration ; it cannot be used as a basis for generalisation. Thus the chosen basis cannot be accepted with full confidence.

The described indicator which attempts to take account of the influence of the changing weight of hulls is shown in Fig. 2. With the construction of this indicator we can take the second step, and investigate the cost of hulls per ton weight.

The possibility of obtaining costs per ton of hulls from the *Navy Estimates* was examined, but direct use of the information was impossible. The longer construction period was a handicap, and there was also an apparent upward bias due to the improving quality of the materials required for these vessels (cf. Fig. 2). Great help has been obtained from a notebook kept by the production manager of a well-known shipbuilding firm and recording construction costs during the eighties and nineties. The carefully kept notes point to the conclusion that, apart from temporary fluctuations caused by the sensitivity of material prices, the wage bill was on the whole equal to the cost of materials.

[10] C. 4797, *The Depression of Trade and Industry, Third Report* (H.M.S.O., London, 1886), p. 145.

[11] W. Denny, 'On the Economical Advantages of Steel Shipbuilding', *Journal of the Iron and Steel Institute*, 1881, p. 65.

[12] Including contemporary estimates of savings of materials of 18-22 per cent. due to the use of steel.

Thus for reconstructing costs per ton of hull weight a combination of two indices is suggested, an index of the cost of ship plates and an index of shipbuilding wages. The cost of ship plates is measured for 1860-85 by the average export price of non-galvanised iron sheets and plates, and for 1886 onwards by the export price of steel plates and sheets. Wage rates are measured for 1880-1910 by the index of engineering wages,[13] and for earlier years the index is extended on the basis of the series collected by Wood.[14] The two series are combined with equal weights for 1905-09. The index of cost per net registered ton from 1863 to 1910 is a straight product of the above indices of cost per unit weight and of average weight of hulls per net registered ton. The series in absolute values has been obtained by tying this index to the actual average value of hulls in ships exported in the period selected as base, *i.e.* 1905-09.

Cost of Machinery

The *Navy Estimates* were more helpful here than they were for the costs of hulls. Again, because of differences in accessories, the series for cost per H.P. is an index, absolute costs being obtained by applying the index to the average value of machinery in ships exported in the period 1905-09. Short-term fluctuations have been removed by taking a three-yearly moving average ; and the longer period of construction of naval vessels has been allowed for by shifting the whole series back one year, *i.e.* before the year of launching.[15] The horsepower installed in merchant vessels has been estimated from samples of new ships in each year taken from *Lloyd's Register,* the resultant series of average I.H.P. per net ton being smoothed by taking a five-yearly moving average. For economy of space, the development of these components is presented only in Fig. 2. In Table I the estimated cost of machinery can be found from the difference between the total costs and the costs for hulls only.

The great changes in marine engineering during the last decades of the nineteenth century were summarised by a contemporary expert of the Iron and Steel Institute :

'(1) Increase in working pressure from an average of 75 pounds to an average of 150 pounds per square inch. (2) The adoption of the triple and quadruple expansion system, so as to utilise steam of this pressure efficiently. (3) The adoption of artificial means for obtaining

[13] Cmd. 2740, *18th Abstract of Labour Statistics.*

[14] G. H. Wood, 'Real Wages and the Standard of Comfort since 1850', *Journal of the Royal Statistical Society,* 1909, pp. 93, 102.

[15] Compare the original curve of cost of machinery per H.P. in Fig. 1 with the smoothed curve in Fig. 2.

sufficient draught for the consumption of coal, and, when desired, for an increased consumption of coal, so as to give an augmented supply of steam without additional boiler capacity, with the result that in naval ships now, with practically the same weight of machinery, the I.H.P. is 50 to 70 per cent. more for the same weight of machinery as was used 15 years ago."[16]

A full economic evaluation of the technological changes implied here and in the earlier discussion of hull weight would amount to writing both a full history of shipping during the last hundred years and an analysis of the impact of steel on economic development as a whole, especially since the middle eighties. For example, the curve of the construction cost of naval propelling-machinery (Fig. 1) could be taken as exemplifying the development of power plant in general. It would not be surprising if further investigation confirmed that this series is, in fact, expressing the most important features of the impact of technological development on contemporary capital formation.

III

Costs Reviewed and Compared with Other Information

A full review of costs would repeat much that has already been said about the revolutionary influence of materials, or describe what can be seen from the Figures and Tables. The aim of this Section is merely to provide some guidance to the main features in the development of costs.

In interpreting the indicators of costs one must keep in mind the significant differences in shipbuilding between the conditions of demand and of supply. Demand is governed by a complex synthesis of conditions which are specific to the development of shipping—on the one hand the development of world trade, and on the other the development of a number of national merchant fleets built independently of each other. The costs reported in actual transactions suggest a predominance of factors active on the supply side. The causal background shows us that price formation is rooted in extensive markets in which the consequences of developments in all sectors of the economy meet. As the development of the shipping trade is exposed to a number of outside influences, a cleavage between the demand side and the supply side is more likely to produce situations of heavy strain which will find their primary expression in the volume of transactions, the demand side seeming to assert itself more through its influence on the quality of tonnage built.

[16] A. E. Seaton, *op. cit.*, p. 474.

Fig. 2 throws some light on the causal background of the supply side. The distance between the price index of materials and that of wage rates tends to increase the further back we go into the past, apart from temporary disturbances in periods notorious for their dislocation of price relationships. This widening is a feature encountered in all surveys of the long-term development of production costs ; it reflects the rising standard of living over the investigated period. However, the impact of technological change, great as it appears, is not fully revealed because the economic significance of a unit of registered tonnage has substantially increased owing to its higher deadweight and speed.

An interesting synthesis of all the components at work is the share of hulls in the total costs of completed steamers, given as a percentage in Table I. In view of the methods of estimating these figures, the significance of short-term fluctuations must not be exaggerated. The lower sensitivity of the naval figures is responsible for a certain time-lag, and thus for some of the contractions (or expansions) of the share of machinery, especially in times of sudden rises or falls in prices, as in the early seventies. But not all the increases or decreases in the share of machinery can be attributed to this methodological shortcoming. The earlier quotation of contemporary expert opinion (p. 52) explains why the impact of steel in the nineties had relatively more effect on the construction costs of machinery than on those of hulls. Fig. 2 shows a decisive and uninterrupted fall in the Navy's expenditure per H.P. from the middle eighties to the middle nineties. This influence is intensified by the simultaneous and equally consistent fall of H.P. per registered ton. The growth of the optimum size of ships can be brought into the analysis as the most important factor in this connection. This movement may be compared with the mild fluctuation in the price of ship plates, and the concentration within a few years of the impact of steel on the weight of hulls.

After 1910, when the recorded fluctuations in the shares of hulls or machinery are based entirely on actual transactions in the export trade, there is no methodological imperfection. Here, too, there are interesting changes. It appears that years of more intensive demand for shipping space in general tend to coincide with increases in the share of hulls, whereas years of less intensive demand tend to coincide with methods of construction designed to satisfy demands for special shipping services, generally involving a greater expenditure on the equipment of ships. Competition appears to make owners build new ships to satisfy the special requirements of customers even though the available tonnage is not fully employed.

Fig. 1 compares our series for construction costs with other series of construction costs. Series derived from the *Navy Estimates* have only changes in the prices of materials and in wages in common with the costs of merchant vessels, and even these are disturbed by longer construction periods and different specifications. Even with these handicaps the series provide some useful points of comparison. The comparison with Cairncross[17] shows, on the whole, good agreement between his correlated variant and our estimate, though his estimate is a rather more sensitive curve which reflects changes on the demand side whereas our estimate rests on information about changes on the supply side : the two estimates give two pictures of the same phenomenon viewed from the different sides of the market.

In addition to the series presented in Fig. 1, information on other transactions in new ships is presented in Fig. 3. The transactions recorded in Fig. 3 are very scattered ; our knowledge would benefit greatly from more such information. The sample relates chiefly to purchases of liners with specifications above the average, so that it is not surprising that the curve keeps close to the bottom of the area over which the purchases are scattered. On the other hand, the curve of hull costs tends to run above the figures for sales reported by shipbuilders ; the difference between our index and the central values of the reported sales would seem about adequate to cover other concomitant expenditures by shipowners, *e.g.* costs of raising capital, interest on pre-payments, architects' and brokers' fees.

A wider coverage is obtained in the information on the value of ships launched on the Clyde, collected for the *Annual Reports* of the Glasgow City Chamberlain.[17] The average values calculated from this information keep in the lower half of the range of individual sales—also relating to the Clyde—reported to us by shipbuilders. It seems likely that the downward bias is due to the value data being incomplete ; discontinuities in the data suggest difficulties in collection.

Fig. 3 draws attention to the scarcity of data. There is undoubtedly a large stock of information of this sort scattered about in old records, the collection of which would not only help the present inquiry but would be a permanent enrichment of the resources available to future economic historians.

IV

Construction Costs after 1910

Inspection of Fig. 1 explains why, of the two available series of data, the choice has fallen on average export values. *Fairplay's* index of the value of a standard single-deck steamer is designed to express

[17] A. K. Cairncross, *Home and Foreign Investment 1870-1913* (Cambridge, 1953), pp. 125-9.

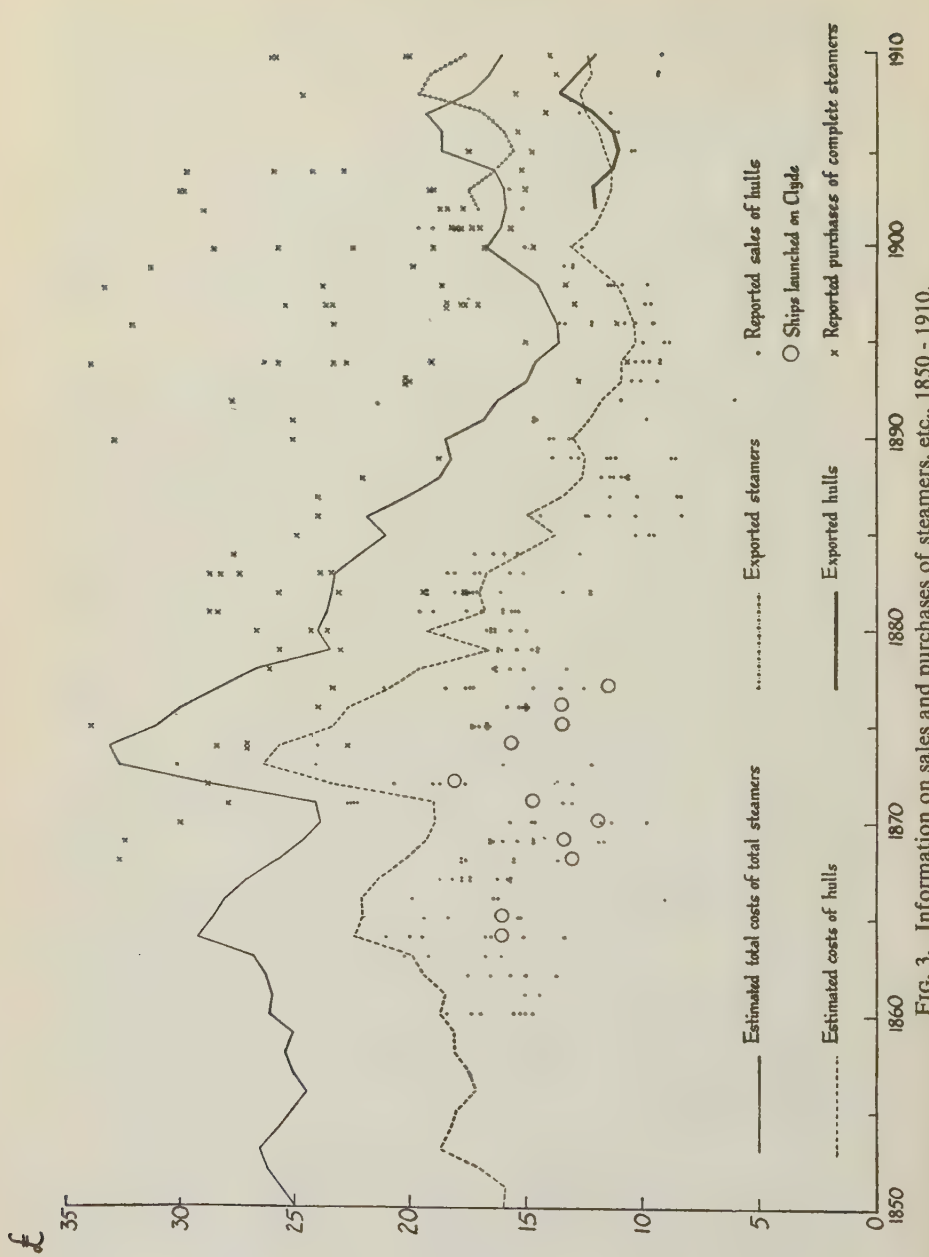

FIG. 3. Information on sales and purchases of steamers, etc., 1850 - 1910.

changes in conditions on the demand side of the market for shipping space.[18] It must, therefore, share the sensitivity of freight rates, which is much higher than the sensitivity of the markets for construction components. The rigidities of price formation on the supply side emerge in the substantially slower changes of the ' shipbuilder's offers ' quoted by *Fairplay* as a counterpart to the computation expressing only changes in conditions on the demand side of the market.[19] Whereas the sensitive value of a single-deck steamer fell with freight rates by about one-half between 1925 and 1933, quoted ' shipbuilder's offers ' for a plain construction (Continental Steel) decreased by only 5 per cent., and for construction with a good specification (British Steel) decreased even less.

TABLE II

THE VALUE AND THE OUTPUT OF NEW SHIPS, 1907-35

	1907	1924	1930	1935
	£ m.	£ m.	£ m.	£ m.
Output of shipbuilders[1]	36·68	53·95	62·21	35·92
Output of marine engineers[1] . . .	3·5 - 4·0	6·80	7·60	5·99
Total output . .	40·18 - 40·68	60·75	69·81	41·91
Deduct:				
Repairs[1] . . .	8·47	17·26	16·21	12·20
War vessels[1] . .	3·51	0·55	4·03	6·37
Change in work-in-progress[1] . . .	?	?	?	3·96
Ships exported . .	9·46	5·21	19·90	2·12
Total output for sale in U.K. . . .	18·74 - 19·24	37·73	29·67	17·26
Estimated value of new registered ships . .	21·0	35·3	29·8	17·3

[1] Information from the Censuses of Production.

The main attraction of the average export values rests on the comparatively large size of this aggregate of transactions in new ships; no rival can be found in accessible sources of information. Over the two inter-war decades, 1920-38, exported tonnage was almost one-

[18] *Fairplay's Weekly Shipping Journal* of 12th January 1939, p. 93, explains the purpose of this indicator. 'When we come to consider the price of a ready 7,500-ton steamer we find that the cost of building bears little or no relation to it, as it is affected by the position of the freight market at the time of delivery.'

[19] *Fairplay's British Shipping Finance* introduced these quotations in 1925.

quarter of the total tonnage built in the U.K. In absolute terms, exported tonnage fell to less than 100,000 gross tons per year only in the lean years of the thirties. With this smaller volume of transactions average export values were exposed to erratic influences; in particular, in 1932 and 1933 they appear to have been upset, and for these years it was necessary to use a substitute based on the movement of the main components in construction costs.

The comparison of the estimated value of new ships with information from the Censuses of Production, which is made in Table II, shows a reasonable degree of agreement, but there are two major defects which leave a margin of uncertainty. First, the value of work-in-progress was included for the first time in 1935, and even then only for the shipbuilding industry. Secondly, the inter-war reports do not give the value of machinery which the shipbuilders included in their returns, nor do they distinguish between the returns of shipbuilders and marine engineers, as in the 1907 *Report*. Comparison of the value of shipbuilding production with export values, made in the 1935 *Report*, is limited to the export value of hulls per gross ton.

The nearest approximation to the amount of machinery produced and fitted to ships by firms other than shipbuilders seems to be the value of production of marine engineers outside the shipbuilding industry. The use of this approximation for 1924, 1930 and 1935 involves the assumption that the duplication caused by shipbuilders who have themselves fitted machines purchased from marine engineers outside shipbuilding and accordingly included these in their returns is about outbalanced by the value of machinery produced by shipbuilders with engineering workshops and fitted in ships built by shipbuilders who are not marine engineers. Only in 1907 does the *Report* give information about this overlap. The importance of changes in work-in-progress[20] and in the value of machinery fitted in ships by firms other than shipbuilders produces considerable uncertainty and impairs the numerical agreement shown in Table II.

[20] Some idea of the importance of work-in-progress can be based on the figures of new tonnage registered in the year after each Census of Production. In 1908 the new net tonnage registered was only 387,000, compared with 716,000 net registered tons in 1907; tonnage exported also fell from 539,000 gross registered tons in 1907 to 430,000 in 1908. In 1925 the new registered tonnage increased slightly to 1,083,000 from 1,020,000 gross registered tons in 1924, and exports went to 175,000 from 151,000 in 1924. Ships completed in 1931 were only about one-half of those in 1930, 472,000 tons compared with 957,000; exports were 306,000 tons compared with 642,000 in 1930. The known change of work-in-progress during 1935 was followed by an increased tonnage completed in 1936—907,000 tons compared with 513,000 in 1935, and exports of 109,000 tons compared with 62,000 in 1935.

Table III

THE VALUE OF THE BRITISH MERCHANT FLEET, 1850-1938

(£m.)

Year	Historical prices		Current prices		Year	Historical prices		Current prices		Year	Historical prices		Current prices	
	First-cost value	Depreciated value	First-cost value	Depreciated value		First-cost value	Depreciated value	First-cost value	Depreciated value		First-cost value	Depreciated value	First-cost value	Depreciated value
1850	63	26	61	27	1880	197	109	175	95	1910	304	149	321	156
1851	65	27	63	27	1881	203	112	175	96	1911	308	150	261	128
1852	68	28	69	29	1882	217	119	189	107	1912	316	156	340	167
1853	74	32	82	35	1883	224	129	202	118	1913	325	163	351	174
1854	79	35	85	37	1884	230	129	197	115	1914	334	166	359	176
1855	83	38	87	40	1885	229	129	185	104	1915	338	165	432	206
1856	83	39	84	39	1886	226	118	193	105	1916	329	157	639	290
1857	87	41	90	42	1887	226	113	179	94	1917	317	166	680	312
1858	90	42	95	44	1888	230	113	173	91	1918	348	199	686	325
1859	90	42	95	43	1889	237	117	180	96	1919	415	237	773	369
1860	91	42	98	45	1890	242	120	191	103	1920	467	274	1068	504
1861	95	44	101	46	1891	247	121	186	101	1921	498	302	991	462
1862	98	46	106	50	1892	252	122	185	100	1922	583	371	1615	762
1863	107	52	120	57	1893	252	120	174	93	1923	617	391	1069	504
1864	117	60	143	70	1894	252	118	175	93	1924	634	393	665	315
1865	124	66	148	74	1895	249	114	166	88	1925	658	397	688	316
1866	127	68	149	75	1896	246	112	170	89	1926	661	381	620	281
1867	128	68	144	72	1897	241	108	175	91	1927	662	366	498	226
1868	129	68	137	68	1898	247	112	189	100	1928	689	373	612	281
1869	129	68	131	66	1899	241	113	204	110	1929	704	369	633	290
1870	132	71	132	67	1900	245	117	225	122	1930	713	355	639	287
1871	136	74	136	71	1901	252	124	225	124	1931	712	335	642	279
1872	144	81	171	91	1902	262	131	234	130	1932	699	307	611	251
1873	153	88	200	108	1903	266	133	241	132	1933	676	276	576	223
1874	165	97	207	115	1904	273	137	256	140	1934	662	251	514	193
1875	172	101	198	109	1905	278	143	272	150	1935	650	236	590	217
1876	176	102	195	106	1906	291	152	287	158	1936	655	235	546	203
1877	183	105	189	102	1907	300	157	309	168	1937	651	232	596	224
1878	190	108	185	101	1908	302	152	309	161	1938	670	234	619	232
1879	194	108	164	89	1909	303	149	296	149					

V

The Value of the British Merchant Fleet, 1850-1938

The estimates of the value of the British merchant fleet have been prepared in six ways, these being the possible combinations from three price alternatives (historical, current and constant prices) and two valuations (first-cost values and depreciated values). Table III summarises the results at historical and current prices.

The computation of these estimates was made possible by information on the tonnage of vessels in use in each year. From 1910 a breakdown by year of completion is available in the *Annual Statement of Navigation and Shipping of the U.K.* For the years before 1910 the age-structure of vessels in use in each year was calculated from information on new ships in each year, the risk of wrecking, the tonnage remaining in service in 1910 (when the age-structure was first recorded), and the total of vessels in use in each year.

The *depreciated value* for each age-group has been calculated from the fully-applied depreciation rate given by the Board of Inland Revenue for ships.[21] For the value at *historical prices* each age-group was valued at the average cost for its particular year according to the prepared series of costs per registered ton. In the series at *current prices* the whole fleet is valued at current construction cost per registered ton in each year—net before 1910 and gross thereafter.

The interpretation of the estimates of the value of the fleet, in Table III and Fig. 4, requires an assessment of changes in physical volume—in the tonnage—of the available stock of vessels, as a background to place the value figures in a proper perspective. For this the period of the survey can be divided into two epochs with essentially different climates. The first epoch, up to the beginning of the First World War, was dominated by a growth of tonnage. This growth was very rapid in the second half of the nineteenth century under the strong stimulus of the two changes in materials, but it was losing momentum by 1910. The second epoch, apart from wartime destruction and subsequent reconstruction, was marked by changes in prices and a process of stagnation which gnawed deeply into the stock of vessels in the early thirties.

For economy of space the changes in tonnage are not described here, but Fig. 4 presents their influence indirectly, in the ratio of depreciated to first-cost value of all registered vessels. This is a synthesis of all the components at work on the development, and it

[21] Board of Inland Revenue, *Income Tax Wear and Tear Allowances for Machinery and Plant* (H.M.S.O., London, 1955).

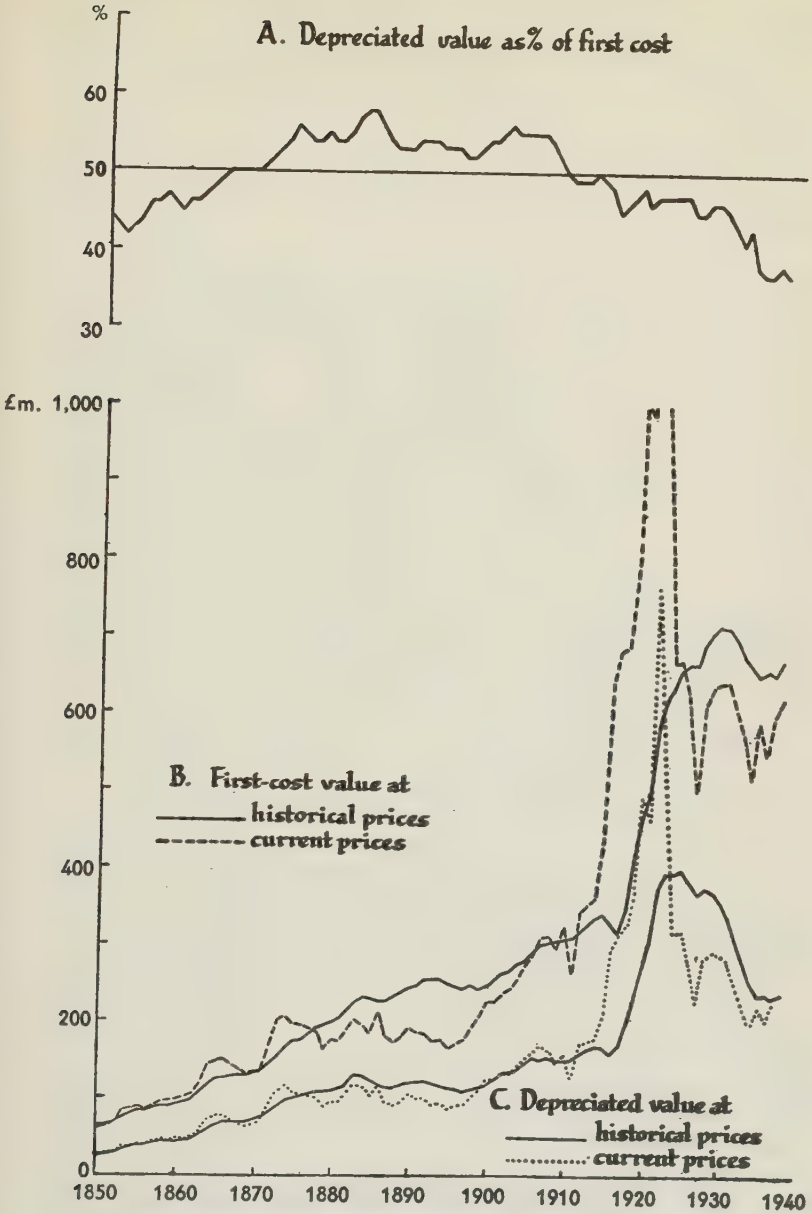

FIG. 4. The value of the British merchant fleet, 1850-1938.

0 5

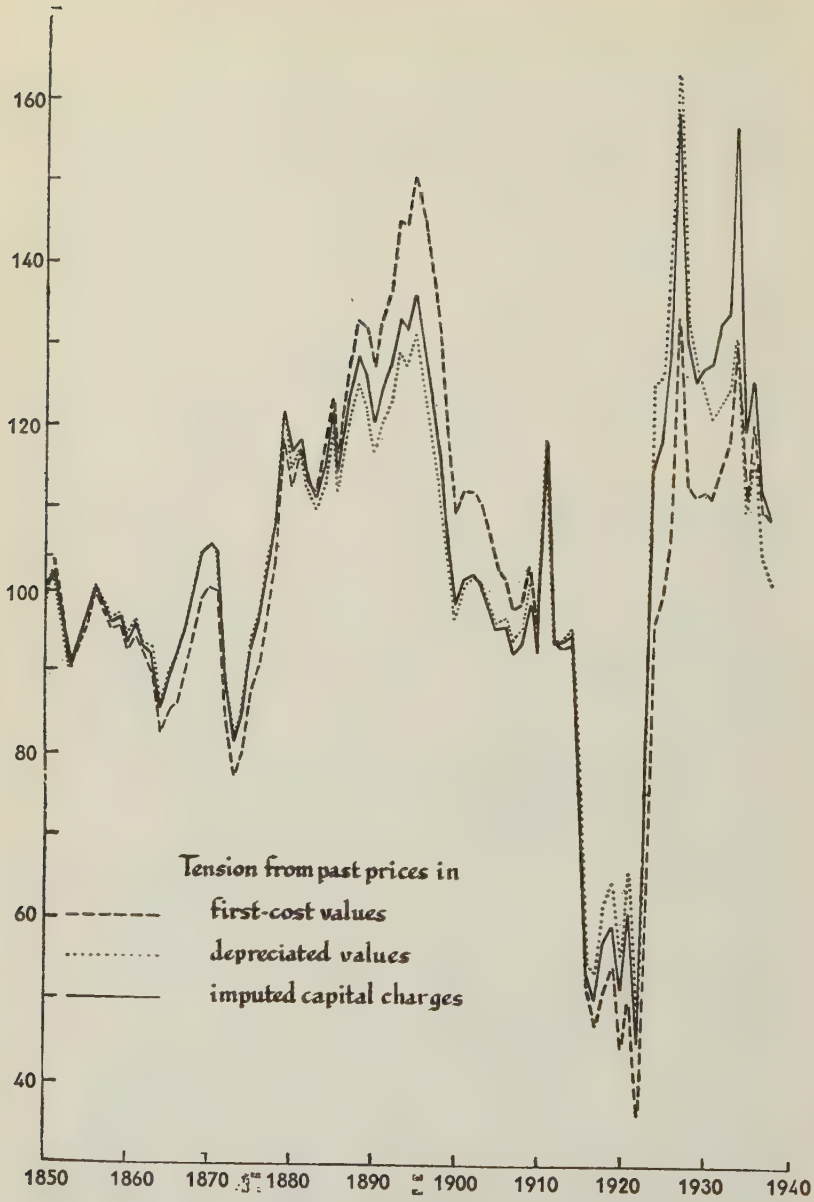

FIG. 5. Past prices and the valuation of vessels, 1850-1938.
(Current prices = 100)

expresses the average age of the fleet, measured by the fully-applied depreciation rates of the Inland Revenue. The arrival of iron speeded the growth of the available tonnage, and the strong stream of new vessels rejuvenated the age-structure and kept its depreciated value constantly above 50 per cent. up to the middle of the first decade of this century. The high turnover in the stock of vessels in the seventies and eighties had a further stimulus through the comparatively higher risks of wrecking, but this fell later with the technical progress of sea transport.[22]

The impact of price fluctuations is shown in a condensed form in Fig. 5. The series of the stock of assets in use, with a breakdown by age, and that of construction costs, both of which are available for almost ninety years, offer a rare opportunity for examining the impact of past prices on the conditions of a trade. Each of the three indicators of the tension of past prices compares values based on historical prices with values at prices prevailing in a given year, the latter being taken as 100. Thus 100 expresses a full reconciliation between a valuation originating in historical prices and the replacement costs of the given year; 80 indicates a deviation involving understatement in capital accounts by its difference from 100; and 120 indicates an opposite disturbance in the relation of capital and profit accounts. The total impact of past prices on the capital charges of a given year is calculated on the assumption that depreciation (related to first-cost value) is provided for at full rates, and that all necessary capital (depreciated value) is borrowed at a fixed rate of interest (5 per cent.).

Fig. 5 suggests a number of lines of analysis, some of them requiring a wider investigation of the impact of past prices on general economic development. Here, however, we cannot go beyond a short account of its main features. Of the ninety years covered by the investigation, only a small proportion reveals the optimum relationship of 100 per cent. Deviations upwards, intensifying the burden of valuation from past price-situations, have been more frequent and substantially larger than those in the opposite direction. From the earlier examination of construction costs, we know that technological changes have had a deeper impact in this than in other sectors of the economy. Thus a use of the term 'deflationary' may not be quite legitimate; but, for brevity, it might be permissible to say that, in shipping, situations in which there are conditions resembling deflationary pressure have been more frequent and of greater consequence than those which appeared to be inflationary. This may be merely a specific

[22] The annual average tonnage of steamers wrecked from 1900 to 1909 was only 1·02 per cent., whereas the annual average from 1870 to 1879 was 2·95 per cent.

feature of development in shipping as technological influences have been more intensive here than in some other parts of the economy. On the other hand, the process of very rapid growth was a compensating force that should have tended to produce a quicker reconciliation with the new level of construction costs.

Some check on these estimates is provided by an analysis of the receipts from stamp duties paid on marine policies. A full report of this analysis would require much space, and only a preliminary statement covering the years 1870 to 1900 is made here. In this period comparatively simple stamp duties were in force ; thus it was possible to separate policies on cargo (one-voyage policies) from those on ships (time policies) with a fairly good chance of reaching an acceptable approximation.[23]

The figures of the value of the ' insured fleet ' obtained from this auxiliary analysis are no more than approximations, and should be used only accompanied by the necessary qualifications. In view of this it is all the more interesting to find a closer correspondence between the insured-fleet and the earlier estimates than might have been expected : the best agreement is with the estimate of the first-cost value of vessels at historical prices. The revaluation of vessels in the light of changing production costs seems to have lagged considerably. The average values for five-year periods in the last three decades of the nineteenth century are :

	' Insured fleet '	First-cost value at historical prices	First-cost value at current prices
	£ m.	£ m.	£ m.
1870-74	150	144	169
1875-79	161	185	187
1880-84	232	214	187
1885-89	195	203	185
1890-94	212	249	180
1895-99	250	244	181

The insured-fleet series shows the presence of the erratic elements mentioned above, and it indicates the direction in which a search for some explanation of the differences established might be made. On the other hand, the use of ten-yearly averages would only make it clearer that our estimates are not contradicted by the information accessible in the insurance transactions.

Further checks are to be obtained from other sources. In its annual survey of the shipping trade for 1882 *The Shipping World* states that ' the grand total of steam tonnage at the end of 1882 will aggregate

[23] Before 1870 the system of duties was complicated, and up to 1869 policies made abroad were not chargeable to stamp duty in the U.K. At the beginning of this century a more complicated system of duties reappeared.

about 6,860,000 gross tons or a deadweight carrying capacity of 9,150,000 tons. If we estimate the price of this immense fleet of merchant steamers at £15 per ton, we get a total value of £137,252,000. To this sum must be added £40,000,000, the estimated value of sailing ships, giving a total for the U.K. of £177,250,000.'[24] Our corresponding estimate, that of first-cost value at current prices, is £189 m., £127 m. for steam vessels and £62 m. for the sailing fleet. £40 m. for sailing ships gives an average of £11 per net ton which is substantially less than the contemporary cost of hulls per gross ton of steamers: apparently the estimate has made a substantial reduction on account of the imminent obsolescence of the sailing vessels. Shortly before the First World War A. W. Kirkaldy estimated the book-value of merchant vessels at £164 m. in 1911, the value of sailing vessels amounting to only a little above £1 m.[25] The corresponding depreciated value at

TABLE IV

THE BOOK-VALUE OF THE MERCHANT FLEET PER GROSS TON, 1920-38

Year	*Fairplay's* sample[1]			Author's estimates[2]		
	Gross tons	Book-value of the fleet	Average value per gross ton	Gross tons	Total depreciated value	Average value per gross ton
	Thousands	£ m.	£	Thousands	£ m.	£
1920	4,204	109·9	26·1	18,598	270·7	14·6
1921	5,187	132·1	25·5	18,289	297·5	16·3
1922	5,006	128·9	25·7	18,834	367·2	19·5
1923	5,198	132·1	25·4	18,753	386·9	20·6
1924	6,222	156·0	25·1	18,883	388·4	20·6
1925	6,280	160·7	25·6	19,334	392·8	20·3
1926	6,489	158·9	24·5	19,229	377·3	19·6
1927	6,086	157·0	25·8	19,175	362·1	18·9
1928	6,728	165·9	24·7	19,889	369·1	18·6
1929[1]	6,315	147·9	23·4	20,232	365·5	18·1
1930	7,075	111·6	15·8	20,332	352·0	17·3
1931	6,792	116·7	17·2	20,092	332·3	16·5
1932	5,987	102·7	17·2	19,420	303·7	15·6
1933	6,628	89·4	13·5	18,321	273·5	14·9
1934	5,917	90·2	15·2	17,705	248·6	14·0
1935	5,642	79·8	14·1	17,298	233·4	13·5
1936	5,616	77·5	13·8	17,502	232·3	13·3
1937	5,703	73·8	12·9	17,446	229·1	13·1
1938	5,591	77·4	13·8	17,737	231·6	13·1

[1] The book-values of the fleet became more accurate after the Companies Act, 1929.
[2] Steam and motor vessels only.

[24] *The Shipping World*, 1883, p. 28.
[25] A. W. Kirkaldy, *British Shipping* (London, 1914), p. 207.

historical prices in our estimate for this year is £150 m., including £3·1 m. for sailing vessels. Kirkaldy's higher estimate is based on the book-values of the fleet in *Fairplay's* sample of balance sheets. Prior to the Companies Act of 1929 this item included the values of some other assets, and estimates based on it have a certain upward bias.

Since 1930 more accurate book-values for the fleet are obtainable from the balance sheets, and for the period 1930-38 *Fairplay's* sample of balance sheets, including mostly passenger and cargo liners with a tonnage of about one-third of total registered tonnage, shows close agreement with the average depreciated value in our estimate. The chosen approximation to the book-value of the fleet, brought in by the Companies Act of 1929, emerges distinctly in Table IV. It may be questioned whether *Fairplay's* sample can be accepted as representative for the whole merchant fleet. These doubts are supported by another sample of balance sheets, published by *Fairplay*, which includes companies with cargo-boats only and covers about 10 per cent. of total registered tonnage. In this sample the average value per gross ton is substantially lower than in the sample of liners; it moves mostly in the region of £11. However, the influence of this group of medium-sized cargo-boats, of about 5,000 - 7,000 gross tons, with the lowest construction costs seems to be outbalanced by the relatively higher construction costs of smaller vessels for which no sample is available.[26]

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[26] The influence of size on construction costs is shown by this comment on *Fairplay's* estimates: 'If an 8,000-tonner is taken at a certain rate per ton, it is found that, for a similar-class vessel with reduced deadweight, at 4,000 tons the rate per ton has increased by £1. Another addition of £1 is experienced at 3,500 deadweight, and further additions of £1 each time are found at deadweights of 2,750, 2,250 and 1,900, while below this the rates per ton increase at a very rapid rate.' (*Fairplay's British Shipping Finance*, 1925, p. 354.)

THE RETAIL DISTRIBUTIVE TRADES IN SCOTLAND

I

LITTLE statistical information of any kind about the structure of retail distribution in Scotland was available until the *Reports* of the Census of Distribution (1950) began to appear in 1952.[1] Earlier studies published in the United Kingdom[2] relate either to England or to Britain as a whole. The Census was taken by the Board of Trade in 1951 in respect of the year 1950, and two comprehensive volumes covering the retail and service trades have been issued. The fullest information so far published relates to Great Britain, but a certain amount is available for Scotland and this forms the principal source of material for the present paper.

II

THE NUMBER OF SHOPS

The Census of Distribution records the number of shops in terms of ' establishments ' ; an establishment is defined as ' a separate place of business engaged in one or more of the following trades : retailing goods ; non-residential catering (excluding public houses) ; hairdressing ; funeral furnishing ; portrait photography ; repairing goods direct for the general public ; retailing motor vehicles, petroleum products, etc., and repairing motor vehicles other than repairing for the trade '. The coverage of the Census did not coincide exactly with the number of shops in the popular sense since it included some hawkers, street traders and itinerant market traders without permanent premises, and industrial and staff canteens to which the general public does not normally have access ; on the other hand it omitted a number of trades frequently carried on in shop premises, such as dry-cleaning, receiving for laundries, dye-works, etc., ticket and travel agencies, and auction sales.

The *Reports* give the number of establishments in existence at the time of the Census. This appears to mean the early months of 1951, the period of completing the census forms. For some of the tables

[1] *Census of Distribution and Other Services, 1950. Retail Trade, Short Report* (H.M.S.O., London, 1952). *Census of Distribution and Other Services, 1950.* Volume I, *Retail and Service Trades, Area Tables* (H.M.S.O., London, 1953). Volume II, *Retail and Service Trades, General Tables* (H.M.S.O., London, 1954).

[2] *Trial Census of Distribution in Six Towns*, British National Committee of the International Chamber of Commerce, 1927. H. Levy, *The Shops of Britain* (London, 1947). H. Smith, *Retail Distribution* (London, 1948).

in the *Reports* population figures are given and these are stated to be the Registrar-General's estimate for 30th June 1950. For the sake of greater accuracy, both as to the figures themselves and as to the period to which they relate, the population figures obtained at the 1951 Census of Population (8th April 1951) are used in this paper.

The total number of establishments recorded in Scotland is 62,687, of which 50,714 are retail, 4,863 catering, 2,430 motor and motor-repair, and 4,680 other service trades. Table I classifies establishments by main business groups[3] and by numbers per 10,000 of the population, and gives comparative figures for England and Wales.

From Table I it is clear that Scotland contains fewer shops in proportion to its population than does England and Wales, the overall difference amounting to about 15 per cent. less. The deficiency is more noticeable in some business groups than in others; those in which Scotland has markedly fewer shops include catering, furniture, bookselling, the motor trade, 'other service trades' and jewellery. It may be significant that all of these are concerned with the distribution of goods and services of a luxury or semi-luxury type. On the other hand, sales per shop are generally higher in Scotland; this suggests that Scottish shops tend to be somewhat larger than in England and Wales though sales per head of population are less. In fact, annual sales per shop were £9,550 in Scotland and only £8,490 in England and Wales, whereas annual sales per head of population were £120·8

[3] The main business groups comprise the following principal trades. Grocer, etc.—grocers and provision dealers, grocers with off-licence, grocers with meat, with bakery goods, with hardware. Other food retailers—dairymen, butchers, fishmongers, poulterers, greengrocers, fruiterers, bread and flour confectioners, cooked meat and delicatessen, off-licences. Confectioners, tobacconists, newsagents—chocolate and sugar confectioners, confectioner-tobacconists, confectioner-tobacconist-newsagents, tobacconists, tobacconist-newsagents, newsagents. Clothing, etc.—boots and shoes, men's wear, women's outerwear, women's underwear, women's outfitters, milliners, furriers, corsetières, infants' and children's wear, men's and women's wear, wool and art needlework, drapers. Hardware, etc.—domestic hardware and ironmongery, china and glassware, radio and electrical goods, electrical goods with contracting, electricity and gas showrooms. Booksellers and stationers (including artists' materials, maps and circulating libraries). Chemists—dispensing chemists, other retailers of chemists' goods, photographic goods. Furniture, etc.—domestic furniture, soft furnishings and floor coverings, antiques, pictures, musical instruments. Jewellery, leather, etc.—jewellery, watches and clocks, leather goods, sports goods, toys, fancy goods. Department and variety stores (including general shops selling a wide range of non-food goods). Coal, corn, etc.—coal, builders' materials, corn merchants. Other retail—florists, nurserymen and seedsmen, pets and pet food, pawnbrokers, general secondhand dealers. Catering—licensed restaurants, catering at railway stations, unlicensed restaurants, cafés, tea rooms, fried fish shops, canteens. Motor trade—motor vehicles, cycles, cycle and motor accessories, cycles and radio goods, perambulators, motor vehicle repairs, filling stations. Other service trades—hairdressers, funeral furnishers, portrait photographers, boot and shoe repairers, watch and clock repairers.

in England and Wales and only £117·5 in Scotland. Further light may be shed on this by examining the geographical distribution of shops. This is done in Table II.

TABLE I

RETAIL AND SERVICE TRADE ESTABLISHMENTS IN SCOTLAND BY BUSINESS GROUPS

Group	Scotland (Population = 5,096,000)		England and Wales (Population = 43,745,000)	
	Establishments	Establishments per 10,000 persons	Establishments	Establishments per 10,000 persons
Grocers, etc.	11,445	22·4	117,900	27·0
Other food retailers	11,962	23·5	114,739	26·2
Confectioners, tobacconists, newsagents	8,288	16·3	58,024	13·3
Clothing, etc.	8,366	16·4	80,680	18·5
Hardware, etc.	2,580	5·1	27,643	6·3
Booksellers, stationers	782	1·5	8,746	2·0
Chemists, etc.	1,799	3·5	14,934	3·4
Furniture, etc.	1,214	2·4	14,872	3·4
Jewellery, leather, etc.	1,190	2·3	12,754	2·9
Department, variety stores, etc.	154	·3	1,511	·3
Coal, corn, etc.	2,064	4·1	18,073	4·1
Other retail	870	1·7	10,553	2·4
Total retail	*50,714*	*99·5*	*480,429*	*109·8*
Catering	4,863	9·5	61,699	14·1
Motor trade	2,430	4·8	26,551	6·1
Other service trades	4,680	9·2	53,398	12·2
Total	62,687	123·0	622,077	142·2

Table II shows that the large cities, the smaller centres which attract visitors from the vicinity and from a distance, and the sparsely-populated Highland and Border counties, which also attract much tourist business, are relatively well provided with shops, whereas the industrial towns and those counties in the central industrial belt which contain many small mining and manufacturing towns and villages, are comparatively poorly serviced. The size of shop, as measured by annual sales, varies with the concentration of population.

Table III carries the analysis further, and gives figures of the number of shops and annual sales per shop for the main kinds of business in Ayr, a regional and tourist centre, and Motherwell and Wishaw, an industrial town. It will be noted that in the food trades there is not a great deal of difference between the two towns, but in

TABLE II

RETAIL AND SERVICE TRADE ESTABLISHMENTS IN SCOTLAND BY REGION AND BY KIND OF AREA

	Population	Establishments	Establishments per 10,000 persons	Annual sales per establishment
				£
Region[1]				
Highland	286,000	3,676	128·5	8,200
North-eastern	865,000	11,844	136·9	9,100
Central (East)	1,058,000	13,418	126·8	9,900
Central (West)	2,631,000	30,221	114·8	9,900
South-western	148,000	1,912	129·2	8,900
Border	108,000	1,616	149·7	7,900
Kind of area[2]				
Large cities	1,916,000	25,234	131·6	11,100
Industrial towns	574,000	6,339	110·3	9,800
Regional and tourist centres	567,000	9,131	161·0	10,800
Remainder: Counties mainly agricultural	909,000	11,106	122·2	7,300
Remainder: Counties mainly industrial	1,130,000	10,877	96·3	7,200
Total	5,096,000	62,687	123·0	9,600

[1] The regions cover the following counties: Highland—Argyll, Caithness, Inverness, Orkney, Ross and Cromarty, Sutherland and Zetland; North-eastern—Aberdeen, Angus, Banff, Kincardine, Moray, Nairn and Perth; Central (East)—Clackmannan, East Lothian, Fife, Kinross, Midlothian and West Lothian; Central (West)—Ayr, Bute, Dunbarton, Lanark, Renfrew and Stirling; South-western—Dumfries, Kirkcudbright and Wigtown; Border—Berwick, Peebles, Roxburgh and Selkirk.

[2] The areas comprise the following: large cities—Aberdeen, Dundee, Edinburgh and Glasgow; industrial towns—Airdrie, Barrhead, Bo'ness, Buckhaven and Methil, Clydebank, Coatbridge, Cowdenbeath, Dumbarton, Grangemouth, Greenock, Irvine, Johnstone, Kilsyth, Kirkintilloch, Motherwell and Wishaw, Paisley, Port Glasgow, Renfrew and Rutherglen; regional and tourist centres—Alloa, Arbroath, Ayr, Bathgate, Dumfries, Dunfermline, Dunoon, Elgin, Falkirk, Forfar, Fraserburgh, Galashiels, Hawick, Hamilton, Inverness, Kilmarnock, Kirkcaldy, Montrose, Musselburgh, Perth, Peterhead, Prestwick, Rothesay, Saltcoats, Stirling; remainder of counties mainly agricultural—Aberdeen, Angus, Argyll, Banff, Berwick, Bute, Caithness, Dumfries, East Lothian, Inverness, Kincardine, Kinross, Kirkcudbright, Moray, Nairn, Orkney, Peebles, Perth, Ross and Cromarty, Roxburgh, Selkirk, Sutherland, Wigtown and Zetland; remainder of counties mainly industrial—Ayr, Clackmannan, Dunbarton, Fife, Lanark, Midlothian, Renfrew, Stirling and West Lothian.

TABLE III

SHOPS AND ANNUAL SALES IN AYR AND MOTHERWELL AND WISHAW

Group	Ayr (Population = 43,000 No. of shops = 720)		Motherwell and Wishaw (Population = 68,000 No. of shops = 759)	
	Shops per 10,000 persons	Annual sales per shop	Shops per 10,000 persons	Annual sales per shop
		£		£
Grocers, etc.	24	12,600	22	12,200
Other food retailers	23	10,000	21	9,200
Confectioners, tobacconists, newsagents	19	7,100	14	6,500
Clothing, etc.	32	14,200	17	14,600
Hardware, etc.	7	14,100	5	6,400
Booksellers, stationers	2	7,900	1	4,200
Chemists, etc.	5	9,900	3	8,200
Furniture, etc.	7	30,000	2	20,100
Jewellery, leather, etc.	7	8,200	3	5,600
Coal, corn, etc.	4	10,900	2	12,600
Catering	19	5,400	10	3,900
Motor trade	7	39,400	4	21,600
Hairdressing	7	2,200	5	1,400

hardware, bookselling, furniture and jewellery, leather, etc., Ayr is very much better provided, and the shops do much more business. The same is true of the service trades. The clothing trades show some interesting variations. Ayr has slightly fewer boot and shoe shops, but they do nearly 50 per cent. more business in spite of the difference in population. In the more specialised businesses of men's wear and of women's outer- and under-wear and outfitting, Ayr has 50 per cent. more shops and their annual sales are nearly three times the annual sales in Motherwell and Wishaw. On the other hand, in the less specialised outfitting and drapery businesses, while Ayr has 25 per cent. more shops than Motherwell, those in the latter town have between them twice the turnover. Thus the pattern of shops reflects the economic and social character of the town.

III

SALES BY SHOPS

The annual sales for the main business groups are given in Table IV. The total of retail sales, £518 m., gives an average of about £100 per person, or £350 per household, as the amount spent for the year on goods from retail shops. These figures may be of some interest

TABLE IV

ANNUAL SALES OF RETAIL AND SERVICE TRADE ESTABLISHMENTS IN SCOTLAND BY BUSINESS GROUPS

Group	Establishments	Annual sales	Average per establishment	Average per establishment in England and Wales
		£000s	£	£
Grocers, etc.	11,445	138,368	12,100	8,800
Other food retailers	11,962	93,547	7,800	7,200
Confectioners, tobacconists, newsagents	8,288	50,749	6,100	6,900
Clothing, etc.	8,366	98,558	11,700	9,700
Hardware, etc.	2,580	18,046	7,000	7,200
Booksellers, stationers	782	6,084	7,800	7,100
Chemists, etc.	1,799	14,872	8,300	9,600
Furniture, etc.	1,214	24,661	20,300	15,700
Jewellery, leather, etc.	1,190	7,915	6,600	5,600
Department, variety stores, etc.	154	39,289	255,100	285,900
Coal, corn, etc.	2,064	20,533	9,900	9,200
Other retail	870	4, 983	5,700	4,600
Total retail	*50,714*	*517,604*	*10,200*	*9,200*
Catering	4,863	24,291	5,000	4,100
Motor trades	2,430	49,999	20,600	18,700
Other service trades	4,680	7,026	1,500	1,300
Total	62,687	598,920	9,500	8,400

in connection with estimates of consumption, family budgets, etc. The average annual takings figure of about £10,000 per shop is not very meaningful because of the great variation between large and small shops. This is analysed in Table V.

To some extent the differences revealed in Table V are caused by variations in the physical size of the shop premises. For example, the comparatively high proportions of grocery, clothing, furniture and motor-trade establishments in the larger sales-groups are doubtless due to the fact that many of the undertakings operating in these trades, especially those conducted by multiple branch organisations, use larger-than-average premises ; and the large proportions of establishments in bookselling, jewellery, catering and other service trades found in the smallest sales-groups are due to the comparatively small-scale premises often used in these trades. But this factor does not account for all the differences in the amounts of annual sales shown in Table V. Another important influence is the size of the gross margin with which

TABLE V

THE SIZE-DISTRIBUTION OF ESTABLISHMENTS IN SCOTLAND ACCORDING TO ANNUAL SALES AND BUSINESS GROUPS

Group	Size of establishment as measured by annual sales						Gross margin as % of sales, G.B.
	Under £1,000	£1,000 and under £2,500	£2,500 and under £5,000	£5,000 and under £10,000	£10,000 and under £25,000	£25,000 and over	
	%	%	%	%	%	%	%
Grocers, etc.	3·7	11·6	21·6	26·1	25·1	11·9	*15·3*
Other food retailers	5·5	14·4	28·3	31·1	17·5	3·2	*23·8*
Confectioners, tobacconists, newsagents	7·2	20·4	29·1	27·6	13·8	1·9	*12·9*
Clothing, etc.	16·6	16·0	20·4	20·5	17·4	9·1	*24·8*
Hardware, etc.	15·4	22·9	24·9	19·8	12·6	4·4	*27·3*
Booksellers, stationers	20·4	22·4	22·4	17·9	11·9	5·0	*30·0*
Chemists, etc.	3·1	6·5	25·5	44·2	18·0	2·7	*31·2*
Furniture, etc.	16·9	16·4	14·4	13·6	17·9	20·8	*27·5*
Jewellery, leather, etc.	17·4	24·9	23·9	17·8	11·0	5·0	*30·3*
Coal, corn, etc.	11·8	15·9	22·5	25·3	16·2	7·3	*23·4*
Catering	18·2	32·2	26·0	14·0	7·1	2·7	*42·0*
Motor trade	8·1	14·9	18·3	20·4	21·7	16·6	*21·5*
Other service trades	62·7	25·5	6·9	3·2	1·5	0·2	*64·1*

different kinds of business work. The gross margin is the difference between the value of sales and the value of purchases for the year less the value of opening stocks plus the value of closing stocks. Unfortunately, the published results of the Census of Distribution do not give information regarding gross margins for Scotland ; the results for Great Britain are given in the last column of Table V. Assuming that similar percentages apply in Scotland, it will be seen that in many kinds of business small annual takings are offset by relatively high gross profit margins, *e.g.* bookselling, jewellery, catering and the ' other service trades '. Conversely, large annual sales are often correlated with low gross margins, *e.g.* grocery, clothing, the motor trade.

IV

THE SIZE OF BUSINESSES

The Census provides information about the number of shops operated by co-operative societies and by firms with single shops and varying numbers of branches. Sixty-nine per cent. of all shops in Scotland are operated by firms with only one establishment ; 9 per cent. are co-operative society branches ; 9 per cent. are run by firms operating from two to four branches ; and, at the other end of the scale, 7 per cent. of all retail shops belong to large organisations

operating more than fifty branches each. The remaining 6 per cent. of shops are run by the smaller multiple organisations operating anything from five to fifty branches. These proportions vary considerably from one kind of business to another. For example, 89 per cent. of all booksellers and stationers, 83 per cent. of all confectioners, tobacconists and newsagents, and 82 per cent. of all catering establishments are run by single-shop firms. The large multiples are most in evidence in the grocery and clothing groups, with 11 and 10 per cent. respectively of all shops operated by firms with fifty or more branches. In the smaller multiples, the groups of 'other food retailers' and chemists have 17 per cent. and 14 per cent. respectively of the total number of shops run by firms operating from two to nine branches. The co-operative movement is strongest in the grocery and 'other food' groups, where it is responsible for 15 per cent. of all shops, and in the chemist and the 'coal, building materials and corn' groups, where it operates 10 per cent. and 9 per cent. respectively of the total number of establishments.

TABLE VI

THE NUMBERS AND SALES OF RETAIL AND SERVICE ESTABLISHMENTS IN SCOTLAND BY FORM OF ORGANISATION

Group	Co-operative societies		Other organisations with branches as follows:								All organisations	
			1		2-4		5-49		50 and over			
	Establishments	Sales	Establishments	Sales	Establishments	Sales	Establishments	Sales	Establishments	Sales	Establishments	Sales
	%	%	%	%	%	%	%	%	%	%	%	%
Grocers, etc.	15	37	64	37	6	7	4	5	11	14	100	100
Other food retailers	15	25	61	45	13	14	8	12	3	4	100	100
Confectioners, tobacconists, newsagents	1	2	83	77	6	9	2	5	8	7	100	100
Clothing, etc.	7	14	66	43	9	11	8	16	10	16	100	100
Hardware, etc.	3	6	75	64	10	12	4	7	8	11	100	100
Booksellers, stationers	—	—	88	79	10	11	2	10	—	—	100	100
Chemists, etc.	10	11	67	52	14	13	5	12	4	12	100	100
Furniture, etc.	7	14	73	50	11	11	7	17	2	8	100	100
Coal, corn, etc.	9	15	78	70	6	7	6	7	1	1	100	100
Total retail	*9*	*20*	*69*	*48*	*9*	*10*	*6*	*10*	*7*	*12*	*100*	*100*
Catering	1	2	84	66	7	11	3	10	5	11	100	100

In terms of sales, of course, the position is very different. Single-shop firms, though 69 per cent. of all shops, account for only 48 per cent. of total sales; the 9 per cent. of establishments which are co-

operative society branches account for 20 per cent. of the sales; and the 7 per cent. which are operated by large multiple organisations have 12 per cent. of total sales. The figures are given as percentages in Table VI.

TABLE VII

ANNUAL SALES IN RETAIL AND SERVICE ESTABLISHMENTS IN SCOTLAND BY FORM OF ORGANISATION

Group	Private and company businesses with establishments as follows:			Co-operative societies
	1 only	2-9	10 and over	
	£	£	£	£
Grocers, etc.	7,000	14,700	14,400	30.500
Other food retailers	5,900	8,600	10,400	13,300
Confectioners, tobacconists, newsagents	5,600	9,800	6,800	22,200
Clothing, etc.	7,400	16,200	22,400	23,000
Hardware, etc.	5,900	11,700	11,100	13,000
Booksellers, stationers	7,000	15,300	38,300	—
Chemists, etc.	6,500	8,700	21,100	9,200
Furniture, etc.	13,800	20,400	67,600	39,000
Jewellery, etc.	5,500	10,500	18,100	—
Coal, corn, etc.	8,800	12,500	10,400	17,500
Other retail	4,600	7,900	12,800	10,300
Total retail	*7,000*	*11,100*	*17,500*	*22,300*
Catering	3,900	9,200	13,700	7,300

Table VII gives the annual sales per shop according to the size and type of organisation. While in certain trades, such as clothing, books and chemists' goods, the large multiples possess the shops with the highest turnover, in other cases, chiefly the food trades, there is no great difference in turnover per shop between the firm with few branches and the larger multiples. Co-operative shops have, in general, comparatively large turnovers, but exceptions are found in chemists' goods and catering.

V

EMPLOYMENT IN SHOPS

The Census of Distribution gives information about the number of working proprietors and unpaid helpers on the one hand, and of employees on the other, distinguishing in each case between part-time and full-time occupation and between males and females. Table VIII summarises the information for Scotland.

The total of 310,000 represents about 14 per cent. of the whole occupied population of Scotland. A comparison with the figures given

TABLE VIII

THE NUMBER OF WORKING PROPRIETORS, UNPAID HELPERS AND PAID EMPLOYEES IN SHOPS IN SCOTLAND

Group	Working proprietors and unpaid helpers				Paid employees			
	Full-time		Part-time		Full-time		Part-time	
	M	F	M	F	M	F	M	F
Grocers, etc.	5,233	3,297	585	1,594	18,215	19,205	2,107	2,664
Other food retailers	6,573	2,449	565	1,437	22,009	15,361	2,459	3,399
Confectioners, tobacconists, newsagents	3,876	3,665	664	1,584	1,456	6,329	3,005	3,886
Clothing, etc.	3,156	2,910	307	929	8,941	24,087	366	3,839
Hardware, etc.	1,726	426	181	310	3,911	2,333	336	598
Booksellers, stationers	468	247	68	121	1,000	1,482	464	279
Chemists, etc	1,110	185	42	180	1,825	4,043	218	690
Furniture, etc.	803	201	74	150	4,375	2,988	77	403
Jewellery, leather, etc.	851	219	58	139	1,362	1,498	67	318
Coal, corn, etc.	1,627	131	201	176	6,212	1,073	366	211
Total retail	*25,932*	*13,886*	*2,827*	*6,736*	*74,963*	*91,131*	*10,489*	*17,722*
Catering	2,498	1,678	364	883	3,046	17,770	326	5,382
Motor trade	2,080	182	195	297	15,076	2,735	198	437
Other service trades	3,548	786	286	422	3,838	3,110	286	567
Total	34,058	16,532	3,672	8,338	96,913	114,746	11,299	24,108

in the preliminary reports on the 1951 Census of Population [4] shows a satisfactorily close resemblance. The Population Census figures, including an unidentifiable number engaged in the wholesale trade, total 265,000 for the same headings of the Standard Industrial Classification as were employed in the Census of Distribution. The latter Census gave a total of 262,000 persons engaged full-time. Comparison with figures of employment published by the Ministry of Labour[5] shows a similar close approximation. For the end of May 1950 the Ministry of Labour employment figures give a total of 216,000 persons employed

[4] *Census 1951: Great Britain One Per Cent. Sample Tables*, Part I (H.M.S.O., London, 1952).

[5] *Tables relating to Employment and Unemployment in Great Britain, 1948, 1949 and 1950* (H.M.S.O., London, 1951).

in the same categories of the Standard Industrial Classification compared with 212,000 recorded by the Census of Distribution.

The figures do not support the common belief that the distributive trades are predominantly the preserve of women. As a full-time occupation they embrace almost exactly equal numbers of men and women. It is true that part-time women exceed part-time men in numbers by more than two to one, but part-time workers account for only about 15 per cent. of the total.

The proportion of part-time working proprietors and unpaid helpers does not vary greatly from one kind of business to another, the confectionery-tobacconist-newsagent and catering businesses having slightly larger ratios as might have been expected. Table IX gives the figures and shows that the variation is much more marked in the case of paid employees. The confectionery-tobacconist-newsagent trade employs nearly half its labour force as part-time workers. At the other extreme, the motor and furniture trades employ quite small proportions of part-time workers.

TABLE IX

PERCENTAGES OF FULL-TIME OCCUPATION IN RETAIL AND SERVICE ESTABLISHMENTS IN SCOTLAND

Group	Full-time working proprietors and unpaid helpers	Full-time paid employees
	%	%
Grocers, etc.	80	89
Other food retailers	82	86
Confectioners, tobacconists, newsagents	77	53
Clothing, etc.	83	89
Hardware, etc.	81	87
Booksellers, stationers	79	77
Chemists, etc.	85	87
Furniture, etc.	82	94
Jewellery, leather, etc.	84	88
Coal, corn, etc.	82	93
Total retail	*81*	*85*
Catering	77	78
Motor trade	82	97
Other service trades	86	89
All establishments	81	86

VI

Summary

The Census of Distribution discloses that there were 62,687 establishments in the retail and service trades covered by the Census in Scotland in 1950. This provides 123 shops per 10,000 of population or 81 persons per shop. These are 15 per cent. less than the corresponding ratios for England and Wales.

Large cities, towns which act as regional centres and tourist resorts, and the thinly-populated rural areas of the Highlands and the Borders, are comparatively well supplied with shops. The industrial counties and manufacturing towns are much worse off.

The total sales of retail establishments in Scotland in 1950 amounted to £517 m., or about £350 per household. The service trades had total sales of about £80 m. A substantial proportion of firms in all kinds of business had total annual sales amounting to less than £5,000. The average annual turnover per shop was £9,550, 12½ per cent. more than the corresponding figure for England and Wales.

Co-operative society branches accounted for 9 per cent. of all shops and 20 per cent. of all sales. Large multiples, with fifty or more branches, accounted for 7 per cent. of the number of shops and 12 per cent. of sales. Firms running only one establishment accounted for 69 per cent. of the establishments and 48 per cent. of the sales.

The retail and service trades in 1950 absorbed 310,000 persons as full-time or part-time working proprietors, unpaid helpers or paid employees, amounting to 14 per cent. of the occupied population of Scotland. Full-time employment was provided for approximately equal numbers of men and women. Part-time employment is more frequent for women but does not as a rule account for more than about a fifth of the total number of persons involved except in the case of confectioners, tobacconists and newsagents, where nearly half the employees are part-time.

W. R. Matheson

East Kilbride

CURRENT TOPICS

THE Annual General Meeting of the Scottish Economic Society will be held in Old College, South Bridge, Edinburgh, on Thursday, 22nd March 1956. Tea will be served to members in the Common Room at 4 p.m., and the business meeting will begin at 4.45 p.m. After the formal business, Professor Sir Alexander Gray, C.B.E., will address the Society.

It is intended to publish notes on current research in economics and allied subjects in this section of the *Journal.* It is particularly appropriate that the first note of this kind should deal with the progress of the *Third Statistical Account of Scotland.*

At a meeting of the Glasgow Philosophical Society in 1944 Mr. J. G. Kyd, C.B.E., (then Registrar-General for Scotland), suggested that the time was ripe for the preparation of a *Third Statistical Account of Scotland.* The *First Statistical Account,* usually called the 'Old Statistical Account', was produced at the end of the eighteenth century by Sir John Sinclair and provides an invaluable survey of social and economic conditions in Scotland at that time. It was followed by the *New Statistical Account,* sponsored by the General Assembly of the Church of Scotland, and published between 1832 and 1845. Mr. Kyd proposed that a similar picture of Scotland in the mid-twentieth century should be prepared. The Scottish Council of Social Service and the four Scottish Universities agreed to sponsor the work, and a beginning was made when the Nuffield Foundation undertook to finance the preparation and publication of the first four volumes. These 'pilot surveys' covered the counties of East Lothian, Fife and Ayr and the city of Aberdeen and were published between 1951 and 1953.

After much discussion on how to cover the remaining cities and counties of Scotland, it was decided to follow Sinclair's pattern by making the parish the area studied. Accordingly, local people, mainly ministers and teachers, were invited to write accounts of their own parishes, dealing with the history, the population, the public and social services, the industries and the way of life. The magnitude of this task is revealed when we remember that there are 730 civil parishes in Scotland, but the response was excellent, and by April 1955 no less than 651 parish accounts had been received.

It is intended to publish the parish accounts in separate volumes for each county—occasionally in one volume for two counties. To edit these reports the help of the Universities has been enlisted : Glasgow

University is editing and preparing for publication the accounts of south-west Scotland, Edinburgh is covering the south-east of Scotland, St. Andrews has responsibility for the counties of Fife, Angus and Perth, and Aberdeen for all the northern counties, including of course the Hebrides, Orkney and Shetland.

In Glasgow, at the time of writing, either one or two editors have been appointed for most of the nine counties, Ayrshire having been dealt with already. These editors work under the general supervision of the regional editor, Dr. G. S. Pryde. Their task is to edit the parish accounts for publication, and to try to achieve a uniform pattern without destroying the marks of individual authorship. The raw material for this work is almost complete ; in the whole region only 16 out of 217 parish accounts had not been drafted by October 1955. The second duty of the editors is to compile short introductions of a relatively standardised pattern to the parish accounts for each county. Bute and Renfrew are to be linked in one volume, and Kirkcudbright and Wigtown in another, but each of the other counties is to have a volume to itself. It is hoped to begin publication with Lanark and Dunbarton in 1957.

Similar arrangements, with modifications to suit local problems, are in operation or in plan in the other University regions. In Edinburgh ten editors (eight from the staff of the University, two from Register House) are at work on the parish accounts of West Lothian, Midlothian, Berwick, Peebles, Roxburgh and Selkirk, but different editors, not yet appointed, will take over the edited material for final integration and compilation of the county introductions. In Aberdeen, where Professor H. Hamilton has charge of the scheme, the regional problems are especially difficult. The northern counties have by far the largest number of parishes (266), and the numerous small inhabited islands off the West Coast present special problems. But good progress has been made in editing the parish accounts of Aberdeen, Inverness and Caithness, and it is hoped to begin publication with the volume on Aberdeenshire (to which Mr. John R. Allan is to contribute the introduction).

As the volume on the city of Aberdeen has shown, the general plan of the *Third Statistical Account* has to be modified to deal with the four big Scottish cities. In Glasgow, where the cost of research and publication is being met by a grant made by the Corporation, the volume is being prepared largely as a team project, under a Director and General Editor, in the University Department of Social and Economic Research. The treatment will be by subject categories rather than by parochial or other geographical divisions. In writing the

account the Department will be assisted by other departments of Glasgow University and of the Royal Technical College and, outside the academic circle, by experts from the Church, public service, industry and journalism. Each contributor is drawing upon a vast store of willing co-operation, so that the description of Glasgow ultimately presented will be largely an account by the citizens themselves.

Two surveys have been specially organised by the University to supplement the available information in certain fields. Censuses of church attendance in Glasgow, in 1954 and 1955, have been conducted with the co-operation of all the major religious denominations and preliminary results have already been published in the press. To provide reliable and up-to-date information for the chapters describing the manufacturing industries, an elaborate questionnaire has been circulated, with advance press publicity, to some 1,300 manufacturing firms in the Glasgow area, asking for details of their origins, development and present activities. This enquiry has met with a gratifying response.

In view of the wealth of statistical information concerning Glasgow, in existence but not readily available in a compact form, it is proposed to publish a Statistical Appendix to the main Glasgow volume, but the main volume will, of course, include sufficient statistical material to be complete in itself. It is hoped to publish the two volumes early in 1957.

By associating the powers of observation of the parish writers—the traditional approach—with the modern techniques of the economist, sociologist, historian and statistician, the *Third Statistical Account of Scotland* offers an interesting experiment in the techniques of social survey. It should provide future historians with as valuable a guide to twentieth-century Scotland as the earlier accounts have done for the eighteenth and nineteenth centuries.

* * *

Dr. Arthur Geddes has known the Long Island intimately for many years, and from time to time has enlivened the pages of scientific and antiquarian journals with his comments on the geography, and the economic, social and cultural history of the region. He has now distilled his studies in these different fields, and reproduced them in a single volume.[1] Mr. T. A. F. Noble writes :

'This volume has been beautifully prepared with all the art of the Scottish printer and the Edinburgh University Press. But it has been

[1]Arthur Geddes, *The Isle of Lewis and Harris: A Study in British Community* (Edinburgh University Press, 1955. Pp. xvi + 340. 42s.)

overlong in the still, and some of the ingredients have been made stale by Dr. Geddes' own earlier industriousness in print. Nor do they all blend as smoothly as one would expect in a concoction so long in maturing, for, as the author tells us, the making of the book stretched over thirty-five years. This in itself has led to defects such as the use of pre-war agricultural and social statistics with little effort to bring them up to date. But the main drawback is the uncertainty of the taster's palate about the nature of the potion itself. A careful, perhaps over-elaborate, geographical analysis leads on to a historical treatment, with growing emphasis on the social and economic aspects of the island's story ; at each successive stage there is a tendency to begin further back in the years, so that the reader's sense of time must occasionally be bewildered.

' Sandwiched in between the geography and the history is a good deal of anthropology and folklore. This in itself is not the least valuable aspect of a book which, for all its faults of construction, has charm and a very great deal of merit. To the economist, for example, the assistance of the anthropologist in the study of an economically backward society is indispensable and all too seldom available, and a good deal of what Dr. Geddes has to say on this score is fresh (save where his own earlier work has anticipated his remarks). Unfortunately, possibly because the period of gestation has been so prolonged, there is a tendency for many good points to be buried in a wealth of recondite allusion, and the writing threatens at times to become so oblique and metaphysical—even mystical—as to obscure the clear-cut scientific framework of thought from which it has certainly sprung.

' There is an interesting section on the first Lord Leverhulme's schemes for the island. This is valuable because the author puts the story firmly in the context of the economics of the fishing industry, which has been too often ignored by other writers. But the treatment is too short and in other respects too stereotyped to do full justice to one of the most fascinating episodes in the island's history, an episode that is still one of the best examples of experiment in the planned development of an economically backward society. This is surely the main defect of this otherwise excellent book : there is too little about some of the methods by which an island community may be studied and too much of others to suit most individual tastes. Dr. Geddes is a little too much of an all-rounder to suit the specialist, and too much of a specialist in too many fields to suit the general reader. But this may well be the highest form of praise.'

RECENT ECONOMIC TRENDS

Fertility Changes in Scottish Cities and Counties

For the years 1911 and 1931 Dr. Enid Charles has estimated the gross reproduction rate of Scotland, of each Scottish city and county, and of parts of counties, so as to measure differences in fertility within Scotland.[1] She found that internal fertility differentials fell somewhat between 1911 and 1931. In view of recent changes in demographic habits, it should be of interest to discover whether and to what extent this trend has continued. Statistics of births by age of the mother are available from 1938, so that it is no longer necessary to use fertility data from other countries. The results are currently published for Scotland as a whole, but the potentially available information on counties or other subdivisions of Scotland has been neither published nor extracted. While a gross reproduction rate is officially calculated for Scotland, information on fertility differences within the country is available only in the form of relatively crude fertility indices, and more refined indices must still be obtained in the form of estimates. The main purpose of the present note is to analyse the changes in fertility which have taken place in each city and county between 1931 and 1951.

For an inter-area comparison referring to a given year it is not necessary to work out gross reproduction rates, since ratios of actual to expected births suffice to indicate fertility differentials; but the position is more complex when changes over time are analysed simultaneously with regional variations. Gross reproduction rates appear to be the most satisfactory set of indices for this purpose. They represent the average number of girls which would be born to each new-born girl, at current fertility levels in each age-group, if all such girls survived to the end of their reproductive period. There are more elaborate measures of fertility, but even if the data were available the numbers would be too small for their application to serve any useful purpose. Gross reproduction rates are usually calculated for a single year; but it was felt that the inaccuracy resulting from the small numbers of births observed in the majority of counties would be more serious than that which might arise from using basic population data which are technically not quite appropriate. The calculations have therefore been made for the averages of the years 1930-32 and 1950-52,

[1] Enid Charles, 'Differential Fertility in Scotland, 1911-31', *Transactions of the Royal Society of Edinburgh*, Vol. LIX, 1936-39, pp. 371-83, 673-86.

on the basis of the Census populations and the numbers of births in these six years.

The basic assumption made in estimating the gross reproduction rates for 1950-52 is that the local fertility rates in each age-group depend on the proportions of married and non-married (*i.e.* single, widowed and divorced) women in that age-group, but that, apart from this, a high or a low level of fertility in a city or county is equally marked in all age-groups. A description of the method adopted is given in an Appendix.

For 1930-32 legitimate and illegitimate fertility rates for each age-group in Scotland have been constructed by adjusting the 1950-52 rates proportionately so as to arrive at the actual total of legitimate and illegitimate births. This implies that for all age-groups legitimate fertility is substantially lower in 1950-52 than in 1930-32, while illegitimate fertility is very slightly higher; and that the composite age-specific fertility rates—births per 1,000 women in five-year age-groups—have increased for the ages under twenty-nine and decreased for the ages thirty and over. Using estimates of the numbers of married and non-married women in Scotland, which can be arrived at from figures for Great Britain published by the Royal Commission on Population and figures for England and Wales published by the Registrar-General, the hypothesis has been tested on the 1939 population and found to be fairly realistic. The gross reproduction rates for the individual cities and counties in 1930-32 were then derived on the basis of the same assumption as that made for 1950-52, and the results obtained agree broadly with those given by Dr. Charles for 1931.

The procedure followed allows us not only to construct gross reproduction rates but also to separate their two components, the indirect influence on fertility of variations in nuptiality and the direct effect of variations in legitimate and illegitimate fertility. The ratio of the local to the national gross reproduction rate, or the ratio between the reproduction rates in 1950-52 and 1930-32, can then be considered as the product of these two factors, the second of which is a weighted average of legitimate and illegitimate fertility indices. (The influence of illegitimate fertility is small, but, owing to its very great variability, it is not negligible.)

Table I shows that the levelling process observed by Dr. Charles for the period 1911-31 has continued and made considerable headway during the following twenty years. In 1930-32 there were, apart from the city of Edinburgh, nine counties with a gross reproduction rate below 1 ; in 1950-52 there is not a single city or county left to which this applies. Since, at the present mortality levels, the margin between

TABLE I

THE GROSS REPRODUCTION RATES OF EACH SCOTTISH CITY AND COUNTY, 1930-32 AND 1950-52

City or county	1930-32	1950-52	1950-52 as % of 1930-32
			%
Cities			
Aberdeen	1·075	1·047	97·4
Dundee	1·086	1·148	105·7
Edinburgh	·884	1·011	114·4
Glasgow	1·204	1·160	96·3
Crofting counties			
Argyll	·976	1·216	124·6
Caithness	1·301	1·363	104·8
Inverness	1.148	1·316	114·6
Orkney	1·033	1.340	129·7
Ross and Cromarty	1·102	1.363	123·7
Sutherland	1·079	1·404	130·1
Zetland	·812	1.213	149·4
Other northern counties			
Aberdeen	1·404	1·293	92·1
Angus	·982	1·123	114·4
Banff	1·402	1·312	93·6
Bute	·879	1·073	122·1
Kincardine	1·253	1.217	97·1
Kinross	1·035	1·158	111·9
Moray	1·244	1·322	106·3
Nairn	1·200	1·262	105·2
Perth	·944	1·093	115·8
East Central counties			
Clackmannan	1·056	1·233	116·8
East Lothian	1·187	1·193	100·5
Fife	1·138	1·198	105·3
Midlothian	1·258	1·221	97·1
Stirling	1·234	1·150	93·2
West Lothian	1·422	1·284	90·3
West Central counties			
Ayr	1.176	1.147	97·5
Dunbarton	1.162	1·247	107·3
Lanark	1·410	1·233	87·4
Renfrew	1·188	1·167	98·2
Southern counties			
Berwick	·910	1·120	123·1
Dumfries	1·138	1·170	102·8
Kirkcudbright	1·210	1·273	105·2
Peebles	·889	1·083	121·8
Roxburgh	·863	1·092	126·5
Selkirk	·794	1·027	129·3
Wigtown	1·316	1·425	108·3
Scotland	1·160	1·170	100·9

gross and net reproduction rates is well below 10 per cent., it follows that only the cities of Edinburgh and Aberdeen and the county of Selkirk had net reproduction rates significantly below 1 in 1950-52; and there are four other counties—Bute, Perth, Peebles and Roxburgh

—in which they were near replacement level. Twenty years previously, of course, the margin between gross and net rates was much larger; the Scottish population as a whole just about replaced itself, but there were many counties in which the population failed to do so.

The most spectacular increase in fertility took place in the crofting counties with the exception of Caithness, which started off on a higher level. In 1950-52 all these counties had gross reproduction rates well above the Scottish average. This is not the picture generally associated with the Highlands, though the true story is deducible from other sources. Though the trend in fertility rates does not give a complete demographic picture of these counties, migration being also very important, the high rates are reassuring.

The gross reproduction rate also rose substantially in all the eastern Border counties; and in a few others in which it was very low in 1930-32—Angus, Bute, Perth, and the city of Edinburgh. On the other hand, a fall or a very slight increase is recorded for the three remaining cities, for the agricultural counties in the north-east and south-west of Scotland, and for most of the counties in the central belt, particularly Lanark and West Lothian.

All in all, the negative association between the value in 1930-32 and the change between the two dates is quite a strong one, the rank correlation coefficient being −·827. These changes also substantially modified the regional pattern of high and low fertility in Scotland, which is shown in a rank correlation coefficient of not more than +·623 between the two periods.

The Scottish gross reproduction rate was practically the same in 1950-52 as in 1930-32, but this, of course, is accidental and came about through the effects of two factors cancelling each other; changes in nuptiality tended to raise it by 31 per cent., but changes in legitimate and illegitimate fertility tended to lower it by 23 per cent. The timing of the two changes was also different, the rise in nuptiality having occurred mainly since the war, whereas the pre-war years saw a marked decline in fertility irrespective of nuptiality, after which it fluctuated. In Table II the two components of the reproduction rate and their movements are examined for each city and county.

The first and third columns of figures in Table II show the effect of nuptiality on local fertility, while the second column shows the effect of changes in nuptiality on fertility. Nuptiality, and through it fertility, increased most in those counties in which it was low, thereby depressing fertility, in 1930-32—the crofting counties, most other northern counties except Aberdeen and Banff, and the eastern Border counties. The increase was small in the mining and industrial counties

TABLE II

THE COMPONENTS OF THE GROSS REPRODUCTION RATE FOR EACH SCOTTISH CITY AND COUNTY, 1930-32 AND 1950-52

City or county	Nuptiality component			Legitimate and illegitimate fertility component		
	1930-32 (Scotland =100)	1950-52 (1930-32 =100)	1950-52 (Scotland =100)	1930-32 (Scotland =100)	1950-52 (1930-32 =100)	1950-52 (Scotland =100)
Cities						
Aberdeen	100·5	131·5	101·2	92·2	74·0	88·4
Dundee	97·1	138·3	102·7	96·4	76·4	95·5
Edinburgh	90·7	138·7	96·2	84·0	82·5	89·8
Glasgow	102·1	125·7	98·1	101·6	76·7	101·1
Crofting counties						
Argyll	78·0	152·8	91·1	107·9	81·6	114·2
Caithness	96·3	135·8	100·0	116·5	77·2	116·5
Inverness	81·9	144·0	90·2	120·9	79·6	124·7
Orkney	93·7	156·9	112·5	95·1	82·7	101·8
Ross and Cromarty	71·4	156·7	85·6	133·0	78·9	136·2
Sutherland	79·3	146·9	89·1	117·4	88·6	134·7
Zetland	68·7	180·5	95·0	101·8	82·8	109·2
Other northern counties						
Aberdeen	105·6	126·8	102·4	114·6	72·6	107·9
Angus	91·1	143·6	100·1	92·9	79·6	95·9
Banff	103·9	122·4	97·3	116·3	76·5	115·3
Bute	84·1	150·5	96·8	90·1	81·1	94·8
Kincardine	97·6	135·7	101·4	110·6	71·6	102·6
Kinross	93·7	138·0	99·0	95·3	81·1	100·0
Moray	95·8	141·7	103·9	111·9	75·0	108·8
Nairn	83·4	151·7	96·7	124·0	69·3	111·5
Perth	88·1	139·6	94·2	92·3	82·9	99·2
East Central counties						
Clackmannan	102·1	142·4	111·2	89·2	82·0	94·8
East Lothian	102·7	133·9	105·3	99·6	75·1	96·9
Fife	109·0	131·2	109·5	90·0	80·2	93·6
Midlothian	109·7	126·7	106·3	98·9	76·6	98·2
Stirling	108·1	122·6	101·4	98·4	76·0	97·0
West Lothian	115·7	121·0	107·1	105·9	74·6	102·5
West Central counties						
Ayr	102·8	130·0	102·3	98·7	75·0	95·9
Dunbarton	98·9	133·4	100·9	101·3	80·5	105·7
Lanark	110·6	116·9	98·9	109·9	74·8	106·7
Renfrew	98·3	132·8	99·9	104·3	74·0	99·9
Southern counties						
Berwick	96·6	136·3	100·6	81·2	90·3	95·2
Dumfries	99·1	134·3	101·8	99·0	76·5	98·2
Kirkcudbright	97·9	137·5	102·9	106·6	76·5	105·7
Peebles	87·1	143·1	95·4	88·0	85·2	97·1
Roxburgh	86·2	148·0	97·7	86·2	85·5	95·6
Selkirk	86·8	145·1	96·3	78·9	89·2	91·2
Wigtown	100·6	133·7	102·9	112·8	81·0	118·4
Scotland	100·0	130·7	100·0	100·0	77·2	100·0

such as Lanark, Stirling, Midlothian and West Lothian, in which nuptiality was high in 1930-32. The negative association is very strong, the rank correlation coefficient being −·927. In addition to the obvious explanation of a more uniform, as well as a lower, average age at marriage there is another factor which may have contributed to this development. With greater industrial diversity, there may well be a decreasing tendency for single women to migrate from the chiefly men-employing to the few traditional women-employing areas. This has the statistical effect of levelling out the proportions of married women, and may also raise nuptiality through a better balance of sexes in each area.

In the last three columns of figures only direct fertility, from which the influence of nuptiality has been eliminated, is considered. Here again a levelling process has taken place to some extent: fertility has maintained itself nearest to the 1930-32 level where this was low, particularly in the south-east of Scotland; but in some of the north-eastern counties, in which the 1930-32 level was high, the 1950-52 level is much further below it. But the association between the 1930-32 level and change during the subsequent twenty-year period is far less marked for fertility proper than for the nuptiality effect, the rank correlation coefficient being only −·503. The differentials in legitimate and illegitimate fertility have therefore persisted to a larger extent than the nuptiality differentials.

This is also true in that the cities and counties are very nearly in the same order when ranked by the direct fertility component of their gross reproduction rates in 1930-32 and in 1950-52. The rank correlation coefficient is ·914, whereas the corresponding figure for the nuptiality component is only ·715; thus the ranking of the cities and counties by their proportions of married women has undergone some substantial modification.

On the whole, a large increase in nuptiality went hand in hand with a small decrease in legitimate and illegitimate fertility; and the latter fell more rapidly where the former increased more slightly. The rank correlation coefficient between the two index numbers has the value of +·560. Nevertheless, there is no clear-cut association between the two factors either in 1930-32 or in 1950-52. In both periods the picture is dominated by the extreme examples of the crofting counties, which show a pattern of low nuptiality and high fertility, and of the East Central counties, which show the reverse pattern. The rank correlation accordingly works out at −·021 for 1930-32 and at −·283 for 1950-52.

A partial explanation for the narrowing down of nuptiality and fertility differentials may be sought in the greater degree of intermixture between the populations of the various cities and counties, as evidenced by the distribution of birthplaces of the population. For example, Table III shows that for each group of counties the proportion of the Census population born in the same geographical group has declined between 1931 and 1951. This is not true of the cities ; they are now less than previously the destinations of internal migration.

TABLE III

ENUMERATED POPULATION BY BIRTHPLACE IN SCOTTISH CITIES AND GROUPS OF COUNTIES, 1931 AND 1951

Groups of cities or counties	Year	Percentage of total population born		
		in same group of cities or counties	elsewhere in Scotland	outside Scotland
		%	%	%
Cities	1931	69·5	21·6	8·9
	1951	73·6	18·1	8·4
Crofting counties	1931	81·9	14·4	3·7
	1951	76·1	18·1	5·8
Other northern counties	1931	78·6	17·8	3·6
	1951	72·5	20·6	6·8
East Central counties	1931	71·8	22·6	5·6
	1951	68·9	23·5	7·6
West Central counties	1931	75·2	17·3	7·5
	1951	73·8	18·7	7·5
Southern counties	1931	74·9	16·6	8·5
	1951	69·6	19·0	11·4

A similar result is obtained when individual cities and counties are analysed. For each city the proportion of the Census population which was born there was higher in 1951 than in 1931 ; for each county, except Lanark and Stirling, the ratio was lower. In most counties both the population born elsewhere in Scotland and outside Scotland increased ; and the proportion of the population which was born in other parts of the United Kingdom or abroad increased in every city except Glasgow. This factor may account for part of the movement towards greater uniformity in demographic patterns, but the whole phenomenon can hardly be ascribed to it. In the first place, the cities tended to become more distinct as regards their population composition by birthplace, and, secondly, the corresponding changes in

the counties are small in comparison with the very substantial levelling process which affected gross reproduction rates. The major part of the explanation must be sought elsewhere, and it is not difficult to suggest possible explanations. The war and post-war years brought about many changes in income-distribution and social habits which have tended to bridge the gulf between the various economic and social groups. No longer is there a clear-cut division between groups of high status and low fertility on one level and low status and high fertility on another. The picture becomes much more complex, and it appears that the differences in nuptiality, for example between early marriage in urban and mining areas and late marriage in rural areas, have tended to disappear to an even greater extent.

Summary

1. The gross reproduction rates for Scottish cities and counties have come much closer to each other between 1930-32 and 1950-52. This process has taken the form of spectacular increases in some counties with small populations and decreases by smaller amounts in cities and counties with large populations.

2. To a considerable extent this has been due to reductions in the differences in the proportions of married women in the reproductive age-groups. This may be due not only to greater uniformity in marriage habits but also to less migration of single women to a few areas traditionally employing women.

3. Local variations in legitimate and illegitimate fertility have also diminished, but the pattern of regional differentials has persisted more than in the field of nuptiality.

C. E. V. LESER

Glasgow

Appendix

The gross reproduction rates for 1950-52 were estimated by applying legitimate and illegitimate fertility rates for each five-year age-group from fifteen to forty-nine years, derived for Scotland from births registered in 1950-52 and the Census population, to the number of married and non-married women in each age-group for each city and county. The numbers of expected legitimate and illegitimate births so obtained were added for each age-group and divided by the total number of women in the age-group. From the fertility rates thus calculated a hypothetical gross reproduction rate was obtained, the ratio of which to the Scottish reproduction rate yields an index representing the effect of nuptiality on fertility.

The total number of expected legitimate and illegitimate births was obtained by adding the figures for each age-group. These were adjusted in proportion to the difference between resident and enumerated population, so far as residents of Scottish counties were concerned, to bring the figures into line with statistics of actual births corrected for residence. The ratio of actual to expected births, representing a fertility index irrespective of nuptiality, was then worked out and multiplied by the hypothetical gross reproduction rate to obtain an estimate for the actual gross reproduction rate.

The same procedure was followed for 1930-32, using the legitimate and illegitimate fertility rates constructed for Scotland.

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